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PARTIALLY ACETYLATED COTTON FIBER AND TREATMENTS TO FACILITATE PROCESSING INTO YARN*

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A study has been made of partially acetylated cotton stock and treatments applied to facilitate processing into yarn. Changes in physical properties of the fiber upon acetylation are discussed and difficulties encountered in mechanical processing are described. The investigation of possible methods of overcoming these difficulties, both by the application of antistatic finishes and by spinning blends of small amounts of raw cotton with acetylated cotton, is described. Data are given on strength and heat endurance of yarns spun from small lots of acetylated stock and the results of both the antistatic treatment and the blending upon these properties are shown.

INTRODUCTION

FOR the early development of partially acetylated (PA) cotton, it was possible to acetylate goods of suitable weight in the piece for service tests *(2, 3)*. Acetylation in the piece has the same advantages as the finishing of textiles in the piece, which is the general practice. However, if the PA cotton fabrics desired are too thick and heavy, too tightly woven, or too wide for piece acetylation, the process must be performed on yarn or raw stock to be made up into cloth. There are also, of course, direct uses for PA cotton yarn as in nets, twines, and cords, and for PA cotton stock, as in pads for ironing and pressing.

On the other hand, it should be possible, if a readily spinnable fiber can be produced economically, to make from it most types of goods for which PA cotton is desired. Therefore, in spite of the usual advantages of acetylation directly in the yarn or piece, raw stock treatment might be preferred if a larger scale of operations would allow a more efficient recovery of acetic acid with a correspondingly lower cost of production. Hence the study of the PA cotton fiber and its manufacture into yarn has been a part of the research program of this Laboratory on PA cotton.

PREPARATION AND PROPERTIES OF PA COTTON

Most of the PA cotton stock used in this study was produced from picker lap in 40- to 60-pound lots in a small stainless steel kier using the method reported in a previous publication *(2)*. The stock was not alkali boiled or otherwise purified before the activation step of the acetylation process. These processes had been found to increase difficulties in subsequent mechanical processing. While this acetylation method produced satisfactory stock for exploratory studies, an ordinary kier has the disadvantages of limited circulation and long time required for the uniform exchange of one liquid for another throughout the load. Furthermore, the restricted circulation often leads to difficulties in temperature control. A 6-pound capacity package-dyeing machine (Figure 1) was also adapted for the treatment of raw stock, and experience indicated that such equipment could be readily utilized for acetylation. Further work has been done on a 50-pound capacity combination raw stock and package-dyeing machine.

An acetyl content of 18 to 21% was adopted for the stock used in this study because this degree of substitution gives stock of good heat endurance and rot resistance, while keeping gains in weight, increases in stiffness, and processing costs reasonably low.

CHANGES IN PHYSICAL PROPERTIES UPON ACETYLATION —— When cotton is acetylated it becomes a new fiber. Though retaining the appearance of cotton, it has undergone changes which make it more difficult than ordinary cotton to manufacture into textile products using conventional processing methods on cotton equipment. One of the most apparent changes is in weight. Figure 2 shows the average observed gain in weight fineness of many samples of PA cotton, including cottons of different varieties. The gain for samples of 18 to 21% acetyl is somewhat less than the numerical acetyl content, eg. an acetylation to 20% acetyl content gives a product about 18% heavier. Some of the increase due to chemical combination is offset by greater loss of noncellulose constituents and by lower moisture regain.

The fibers are enlarged in cross-sectional area and are more nearly round than the original raw cotton, to an increased degree with increase in acetyl content. Photomicrographs of cross sections of Stoneville and Lockett cottons, before and after acetylation, are shown in Figures 3 and 4. The increase in Micronaire value is usually more than would be expected from the relationship between weight fineness and acetyl content shown in Figure 2. Typically, a sample of Stoneville cotton (3.2 μg/in on the Micronaire) increased in coarseness by 28% (to 4.1 μg/in on the Micronaire) upon acetylation to 19% acetyl *(8)*, which corresponds to an increase in true weight fineness of about 16%. It may therefore be concluded that the usual cotton scale employed with the Micronaire instrument will not show correctly the change in weight fineness of cotton due to acetylation.

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Figure 1
Dyeing machine adapted for the partial acetylation of cotton raw stock.
William G Sloan, one of the authors, is shown inserting an improvised adapter used for raw stock.

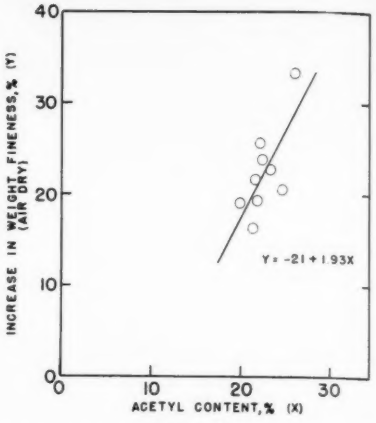

Figure 2
Relationship between acetyl content and increase in weight fineness on acetylation of cotton stock.
Deviations of several percent are frequently observed.

Acetylated fibers become progressively less dense with increasing acetyl content *(6, 7)*. At 20% acetyl, the density is about 1.41 g/cc which would indicate an increase in volume of 37%, not taking into account the loss of soluble matter from the raw cotton. This increase is not necessarily reflected by a corresponding increase in major diameter of the fiber, as the extra volume is apparently accommodated partly in the original lumen space and partly in increased roundness of the fiber (Figures 3 and 4).

The individual cotton fiber loses 5 to 10% strength upon acetylation and, of course, there are more appreciable losses in terms of tenacity and tensile strength, where the increases in weight or volume are taken into account *(5)*. Effects on yarn strength will be considered below.

Other changes affect spinning quality. PA cotton has a moisture regain of only 3 to 4% as compared with 6 to 8% for untreated cotton, the low regain contributing to the need for antistatic agents to facilitate mechanical processing. PA cotton is also of lower elongation *(5)* and somewhat stiffer and harsher in feel than untreated cotton, and has a lower wax content due to partial removal in the acetylation baths. Samples of Lockett and Rowden cottons which had a wax content of 0.50% before acetylation were found to contain only 0.30 and 0.32% after acetylation; a Stoneville cotton was found to contain 0.75% wax before and 0.51% after acetylation. There were also slight losses in fiber length, which may be a result of the swelling which takes place during acetylation together with the restraint of the spiral structure of the fiber, or breakage in sampling and sorting in the preparation of the array. Ten samples including cottons of 3 different varieties showed an average loss of 4.3% in upper quartile length and 7.2% in mean length (Table I). The loss of fiber length apparently tends to increase as the acetyl content increases. Upper quartile and mean lengths were determined by the Suter Webb fiber array method *(1)*. The upper quartile length is the length which is exceeded by 25% of the fibers by weight in the sample; its values are slightly greater than the classer's staple length designations but differ similarly from cotton to cotton.

Finally, PA cotton is likely to be matted to some extent because of usual operations in handling cotton stock in wet processing. All these changes indicate the need for a softener or lubricant to make it behave more like ordinary cotton in mechanical processing.

MECHANICAL PROCESSING

REQUIREMENTS —— The preferred approach to the problem of making textile products from PA cotton stock is to prepare the fiber so that it can be processed on

TABLE I
EFFECT OF ACETYLATION ON FIBER LENGTH
(samples taken from picker lap)

Variety & lot	Acetyl content %	Upper quartile length in	Loss %	Mean length in	Loss %
Stoneville					
72	control	1.18	——	0.92	——
111*	14	1.15	2.5	.87	5.4
112*	20	1.12	5.1	.86	6.5
113*	24	1.10	6.8	.83	9.8
163	20	1.12	5.1	.84	8.7
164*	20	1.12	5.1	.83	9.8
Lockett					
199	control	0.96	——	.81	——
231	20	.93	3.1	.74	8.6
234*	20	.93	3.1	.75	7.4
247*	20	.93	3.1	.76	6.2
Unknown					
99C	control	1.08	——	.85	——
99*	23	1.03	4.6	.80	5.9
100*	23	1.03	4.6	.82	3.5
AVERAGE	——	——	4.3	——	7.2

*Antistatic agent present.

conventional cotton manufacturing equipment with little departure from the usual conditions of operation. However, it has been virtually impossible to card PA cotton on standard type cards without processing aids owing to the generation of static electricity. This static electricity causes the card web to cling to the doffer wire, lapping over the doffer blade. Sometimes the web rolls up as soon as it leaves the doffer rather than flowing out in sheet form like ordinary cotton. At times the sliver clings to the metal calender roll and will not feed into the coiler head and card can. This and other difficulties encountered in the mechanical processing of PA cotton are listed in Table II.

Consequently, ways of making PA cotton more adaptable to mechanical processing must be considered. One practical possibility is to treat the cotton with antistatic agents or finishes comparable to those used on synthetic staple fibers; a second is to blend a moderate amount, 10 to 20%, of untreated (raw) cotton with it; a third might be by chemical combination of a lubricant; and a fourth lies in the use of static eliminators. Of these possibilities, most attention has been given to the first, and only the first two will be discussed in this paper. A fifth treatment consists of spraying the PA cotton with water so as to add 5 to 10% moisture. While probably not practical for large scale use, this method was used in making PA cotton yarns without antistatic agents for comparison with samples treated with such agents.

Although the chemical treatment resulted in a loss of staple length (Table I), the subsequent manufacturing operations had no significant effect on acetylated fibers treated with extra moisture or antistatic agents. Like ordinary cotton, the upper quartile and mean lengths in Table III showed very small increases as the PA cotton stock went from picking to second drawing or roving.

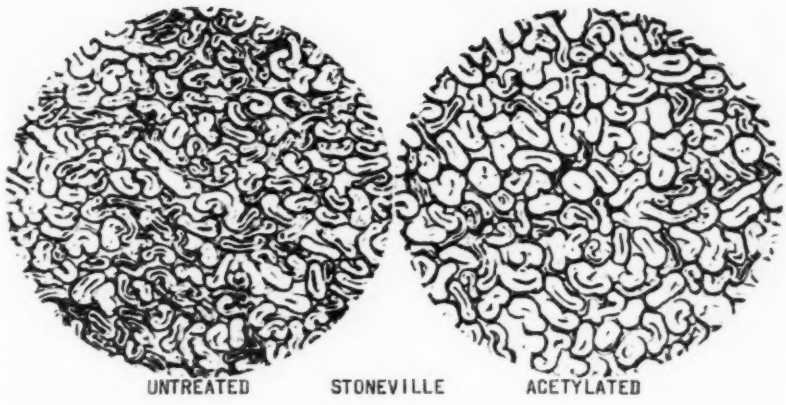

Figure 3
Cross sections of Stoneville cotton fibers before and after acetylation.
Acetylated fibers have an acetyl content of 20%. Photomicrographs are shown at the same magnification.

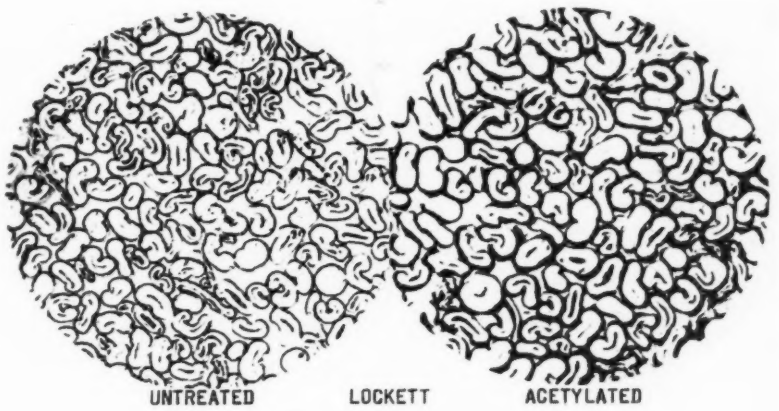

Figure 4
Cross sections of Lockett cotton fibers before and after acetylation.
Acetylated fibers have an acetyl content of 20%. Photomicrographs are shown at the same magnification.

TABLE II
DIFFICULTIES IN PROCESSING FIBROUS PA COTTON ON CONVENTIONAL COTTON EQUIPMENT

1) Static electricity at card and drawing frame.
2) Loading on the card.
3) Nep formation on carding.
4) Poor fiber separation at card and drawing frame.
5) Tendency of drawing sliver to condense (into a ribbonlike form in extreme cases).
6) Nonuniform drafting at drawing and roving frames.
7) Ends down in spinning.

TABLE III
EFFECT OF MECHANICAL PROCESSING ON FIBER LENGTH OF PA COTTON

Variety & lot	Acetyl content %	Upper quartile length			Mean length		
		Picker in	2nd Drawing in	Change %	Picker in	2nd Drawing in	Change %
Stoneville							
72	control	1 18	1 18	0	0.92	0 93	+1
163	20	1 12	1 15	+3	.84	87	+4
164*	20	1 12	1 13	+1	.83	83	0
Lockett							
199	control	0 96	0 97	+1	.80	82	+3
231	20	93	.94	+1	.74	76	+3
234*	20	93	95	+2	.75	78	+4
247*	20	.93	.93	0	.76	75	−1
Unknown							
99C	control	1 08	___	___	.85	___	___
99*	23	1 03	1 05**	+2	.80	82**	+3
100*	23	1 03	1 04**	+1	.82	81**	−1

*Antistatic agent present.
**Roving sample.

PROCESSING AIDS AND HEAT ENDURANCE

Difficulties similar to those encountered in the mechanical processing of PA cotton have been recognized for many years in the textile industry. For example, cotton dyed as raw stock usually does not run as well in the mill as untreated cotton. Efforts to improve the behavior of such cotton include the retention of a small amount of salt from a last rinse in the dyehouse, or the use of sulphonated oils or other softeners or fiber lubricants. Synthetic staple fibers also give trouble, due largely to their propensity toward developing static electricity, and a great number of antistatic agents have been formulated to help mitigate this difficulty. Used as an aid applied before carding such additives are more properly designated as processing aids because they do more than merely overcome trouble from static electricity. Of course, the additives must not promote rusting of the machinery, nor should fiber lubricants cause too much fiber slippage and make the yarn too weak. But, as will be shown, the main difficulty in finding suitable processing aids for PA cotton has been that almost anything added to PA cotton reduces its heat endurance somewhat.

One of the chemicals first used to eliminate static was common salt. It was found that applications as low as 0.15% on the cotton eliminated static sufficiently to allow carding and processing into yarn, although this salt treatment did not furnish any lubrication to the fibers. Hence, the fiber separation was not adequate; the web and silver had a harsh feel; and there was some loading of the card cylinder which tended to increase as the card was run. When the yarn was tested for heat endurance, it was found to retain only 40 to 50% strength rather than the expected 80%. Additional samples of the yarn were soaked in hot water (140°F) and others extracted in boiling water in order to remove the salt and were then tested for heat endurance. Surprisingly, the heat endurance was not improved. Other salts that were tried for eliminating static also reduced the heat endurance (see Table IV).

In the search for a suitable processing aid for PA cotton, a number of pure substances and combinations and many proprietary agents were tried. Most of the materials tested fall into one or more of the following classes: antistatic agents, humectants, softeners, and lubricants. They included anionic, cationic, and nonionic surface-active agents. The agents were usually applied by immersion of the stock in a solution, usually in a ratio of 20 parts solution to 1 part cotton, by weight, at 120°F for 15 minutes. The stock was then centrifuged to a pickup corresponding to the desired amount of the agent, and dried at 200°F. Percentages of substantive, or cationic, agents that were applied were calculated on the weight of the stock. Most of the aids were used on PA cotton at 0.25 to 0.50% of its normal air dry weight. None of the cationic agents tested eliminated static electricty and they were not favored for large masses of stock because of the likelihood of uneven deposition.

As a preliminary screening for mechanical processing, 4-oz samples of air-dry PA cotton stock were treated with processing aids, dried, and then carded unless prevented by generation of static electricity. The samples which could be carded were next put on the drawing frame, and, if they ran satisfactorily, were spun and twisted into 14/3 yarn. The yarns were then compared with control yarns for breaking strength both before and after heat endurance tests to be described.

TABLE IV

EFFECT OF SALTS ON HEAT ENDURANCE OF PA COTTON YARN

Treatment	Strength retained after heating 7 days at 160°C
	%
Controls, 20% acetyl, no additive.	80 (avg)
0.15% sodium chloride	45
.70% sodium chloride	28
0.62% sodium chloride	42
same, water washed, 140°F.	30
same, boiling water washed.	58
0.14% sodium sulfate	55
.14% potassium chloride	49
.18% calcium chloride	53

YARN STRENGTHS BEFORE AND AFTER HEATING —— Properly acetylated cotton yarn or fabric does not show loss of breaking load per strand or test piece upon acetylation. If, however, acetylated fiber is made into yarn, it will be weaker than the corresponding cotton yarn of the same count. This lower strength is attributable largely to the gain in weight of the stock, and the correspondingly fewer acetylated fibers in either type of test piece of a given weight. The loss in terms of either tenacity or tensile strength is commonly about 20% at 20% acetyl content. There is usually an additional loss in tensile strength of 5 to 10% attributable to the lubricating effect of the antistatic agent. Thus, yarn prepared from acetylated and treated stock may have, before heating, only 75% of the strength of unacetylated cotton yarn of the same number. These losses are reflected in the relative count-strength product of the acetylated control yarn shown in Tables V and VI.

To test heat endurance, samples of 14/3 yarn were suspended in a laboratory oven at 160°C for 7 days. Single strand breaking strengths of the yarns before and after heating were obtained in a conditioned atmosphere at 70°F and 65% relative humidity. Control yarns of untreated cotton were also spun and tested, as well as yarns from PA cotton having no added treatment to facilitate processing other than approximately 5% moisture which was added by spraying with water. These controls were used to evaluate the effect of the antistatic treatment upon initial yarn strengh as well as its effect on heat endurance.

Under these conditions PA cotton yarns were found which retained as much as 90% of their original strength after heating, in contrast to as little as 10% strength retained by some unacetylated yarn; average values were about 80% and 15% respectively. These test results are shown in Table V. Since many of the potential major uses for PA cotton require heat endurance, only those treatments which gave yarn retaining 75% or more strength after the test exposure were

TABLE V

STRENGTH RETENTION ON HEATING OF ANTISTATIC-TREATED PA COTTON

(Stoneville cotton, 20% acetyl, 7 days at 160° C)

Lot	Description	Relative count-strength products Gray=100 Before heating	Gray=100 After heating	Acetylated=100 Before heating	Acetylated=100 After heating
		%	%	%	%
72	Control, gray	100	15	—	—
163	Control, acetylated	75	60	100	80
164	0.22% Agent P	68	61	91	81
191	.29% Agent P	72	59	96	78
216	.37% Agent A	82	62	109	82

considered satisfactory.

When the results are based on unheated, untreated cotton yarn taken as 100%, the strength retained is approximately 60%. The retained strength is therefore four times that of untreated cotton after such heating. The strengths of the various yarns before and after heating are shown graphically in Figure 5. To summarize the relationship, the acetylated yarns, though not as strong at the beginning of the test, soon surpass the untreated cotton yarns in strength by a wide margin.

SATISFACTORY PROCESSING AIDS

The more promising treatments were repeated for confirmation on 5-pound lots in the small package dyeing machine already mentioned; and finally applied to two 30-pound lots of air-dry PA cotton for a pilot scale spinning test. This was enough to run on the card, drawing frame, roving frame, and spinning frame for several hours.

Although numerous commercial antistatic agents and processing aids were evaluated, only two were found which were considered promising in that the heat endurance of the yarn was not lowered. Both products are reported to be non-substantive on cotton. Lots treated with these products had better fiber separation and fewer neps in the card web than lots treated with other finishes. Data showing yarn strength and heat endurance of lots treated with these two antistatic agents are shown in Table V. Sixty pounds of Lockett cotton having an acetyl content of 20%, treated with antistatic agent A were processed satisfactorily into yarn. A number of smaller lots treated with mixtures of approximately 9 parts agents A and 1 part agent P also processed satisfactorily.

BLENDS OF ACETYLATED AND UNTREATED COTTON

A few spinning tests have been made with blends of PA cotton with a small amount of untreated cotton. Natural cotton, against the steel surfaces of mechanical processing equipment, develops a charge of opposite polarity to acetate rayon (4). If the same relationship is true with PA cotton, it should serve to neutralize some of the static in PA cotton. Also natural cotton, containing more waxes and oils and having a higher moisture regain than PA cotton, should be expected to have additional advantageous effects. Together, these properties should make ordinary cotton quite effective as an "antistatic agent." Advantages of blending over the use of antistatic agents would be a decrease in the overall cost due to the use of less PA cotton as well as the elimination of cost of the additive treatment.

Five-pound lots of Stoneville PA cotton of 20% acetyl content were blended with small amounts of untreated Stoneville cotton for processing into yarn and determining yarn strength and heat endurance. No antistatic agent was applied to either stock. Two blends were made, one containing 10% untreated and the other 20% untreated cotton. The 10% blend was processed into yarn but produced more static than desirable. The blend with 20% of untreated cotton almost completely eliminated static so that mechanical processing was satisfactory for lots of this size. Data on yarn strength and heat endurance are shown in Table VI. Both blended lots compared favorably with the PA cotton control, that is, the strength retention of the blends after heating is almost as good as that of the PA cotton control, and the original yarn strength is greater. These strength relationships are illustrated graphically in Figure 5.

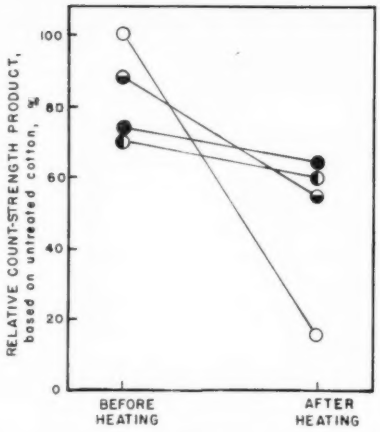

Figure 5
Relative strengths of yarns before and after heating.

●, Acetylated with 5% moisture added to facilitate spinning; ◐, acetylated, treated with an antistatic finish; ◒, acetylated, blended with 20% untreated cotton; ○, untreated cotton. Heated for 7 days at 160°C.

SUMMARY

Partially acetylated cotton stock in thirty-pound and smaller lots has been satisfactorily spun into yarn through the use of selected antistatic agents which have no adverse effect on the heat endurance of PA cotton. Promising results were also obtained using blends of partially acetylated and untreated cotton. The results of these experiments with small lots indicate that most of the major mechanical processing problems encountered with PA cotton fiber can be satisfactorily solved by the use of selected additive finishes, or by blending with a moderate percentage of untreated fiber.

ACKNOWLEDGMENTS

The writers are greatly indebted to the Cotton Mechanical Processing Section, particularly C L Sens and A T Callegan, for conducting numerous processing experiments; thanks are also due to the Analytical, Physical-Chemical, and Physics Section for many physical tests, and to the Cotton Fiber Section for photomicrographs.

TABLE VI

STRENGTH RETENTION ON HEATING OF BLENDED PA COTTON
(Stoneville cotton, 20% acetyl, 7 days at 160° C)

Lot	Description	Relative count-strength products Gray=100 Before heating	Gray=100 After heating	Acetylated=100 Before heating	Acetylated=100 After heating
		%	%	%	%
72	Control, gray	100	15	—	—
163	Control, acetylated	75	60	100	80
249	Blend (10% gray)	82	59	109	78
250	Blend (20% gray)	88	55	116	73

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FLUORESCENCE OF DYES IN SOLUTION

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INTRODUCTION

THE January 1924 edition of the *Colour* Index, edited by F M Rowe and published by the Society of Dyers and Colourists, lists many dyes which exhibit the phenomenon of fluorescence in solution. The shade and intensity of fluorescence is mentioned in the section on "Description—Properties—Mode of Application."

During an investigation on the fluorescence of dyes in solution, it became necessary to know whether the fluorescence recorded in the *Colour* Index had been observed in daylight or in ultraviolet light. Since there is no statement in the *Colour* Index concerning the conditions under which the fluorescence was determined, all of the listed dyes that were available to us for testing were examined under controlled conditions.

SUMMARY

The fluorescence observed in daylight is generally similar to that listed in the *Colour* Index, while in many cases the shade of the fluorescence in ultraviolet is entirely different. In a number of cases it is stated that a solution of a dye is without fluorescence, which is true for daylight, but the solution does have a distinct fluorescence in ultraviolet.

The check tests performed during this investigation prove that most of the comments on fluorescence resulted from observations which were made in daylight.

Fluorescence is often used as an aid in the identification of unknown dyes and it is hoped that the following information will be useful for future reference.

ACKNOWLEDGMENT

The author wishes to thank Daniel P Knowland of Geigy Dyestuffs and Hans Luttringhaus of Progressive Color & Chemical Co for their kindness in supplying samples of old dyes, and to George Chabot, Sr for assistance in performing the experiments and reading the fluorescence.

EXPLANATION OF TERMS USED

Alcohol —3A ethyl alcohol (90% ethyl alcohol, 5% methyl alcohol, 5% water), solution was at room temperature except where noted.

NaOH —10% caustic soda solution.

Colour Index —information copied from *Colour* Index.

Daylight —viewed at a window facing south on clear days.

Dye Solution —25 mg of dye dissolved in 100 ml of the solvent.

HEM —tests and evaluations by the author.

H_2SO_4 Conc —CP sulfuric acid, 1.84 sp gr.

H_2SO_4 Diluted—the concentrated sulfuric acid solution of the dye diluted with water.

Oiled Cotton —soak cotton at room temperature for 3 minutes in a solution containing 100 grams of sulfonated castor oil dissolved in 850 ml of water. Remove, squeeze (do not rinse) and dry. Repeat and then treat in a 1% solution of aluminum acetate for 5 minutes at room temperature. Remove and rinse. Give a light soaping. Dyeings were made with 0.25% of dye on weight of fabric, dye at room temperature for 5 minutes, raise to 100° F, run 5 minutes. Remove, rinse and dry.

Wedge Interference Filter —Bausch and Lomb Optical Co, catalog #33-80-02. When passed before the eye, this filter shows successively the pure colors of the spectrum. A daylight fluorescent color may be recognized by a sharp increase in brightness when the filter is moved so that it transmits that part of the spectrum at which fluorescence occurs.

Wratten Filters —Wratten filters #65 (green) and #29 (red) were used to determine the visible-light fluorescence characteristics of red, orange, etc, dyeings.

Ultraviolet —examined in ultraviolet light rays from a Keese Engineering Company (Hollywood, Calif) Model 90STP, 115-volt, 60-cycle ultraviolet lamp. This lamp emits in the near-visible ultraviolet region.

AURAMINE O (*CI* 655)

Colour Index, Water —bright yellow solution, readily decomposed on boiling.

HEM, Water —*Daylight*—bright yellow solution without fluorescence.

HEM, Water —*Ultraviolet*—yellowish-orange fluorescence.

Colour Index, Alcohol —yellow solution.

HEM, Alcohol —*Daylight*—yellow solution, very slight fluorescence. More concentrated solution shows no fluorescence.

HEM, Alcohol —*Ultraviolet* — greenish-yellow fluorescence — more concentrated solution shows dull green fluorescence.

PYRONINE G (*CI* 739)

Colour Index, Water —red solution with a yellow fluorescence.

HEM, Water —*Daylight*—red solution with a yellow fluorescence.

HEM, Water —*Ultraviolet*—bright orange fluorescence.

Colour Index, Alcohol —red solution with a yellow fluorescence.

HEM, Alcohol —*Daylight*—red solution with a yellow fluorescence.

HEM, Alcohol —*Ultraviolet*—bright-orange-red fluorescence.

RHODAMINE S (*CI* 743)

Colour Index, Water —readily soluble with a red color and a yellow fluorescence; the latter disappears on heating.

HEM. Water —*Daylight*—red solution with a yellow fluorescence. Considerable loss of fluorescence on boiling but still has a noticeable yellow fluorescence.

HEM. Water —*Ultraviolet*—has a reddish-orange fluorescence both cold and boiling.

Colour Index, Alcohol --sparingly soluble with an intense yellow fluorescence.

HEM. Alcohol —*Daylight*—red solution with an intense yellow fluorescence.

HEM. Alcohol —*Ultraviolet* — brilliant reddish-orange fluorescence.

XYLENE RED B (*CI* 748)

Colour Index, Water --bluish-red solution.

HEM. Water --*Daylight*—bluish-red solution with a yellow fluorescence.

HEM. Water —*Ultraviolet*—bright, rich, crimson fluorescence.

Colour Index, Alcohol —bluish-red solution with a yellow fluorescence.

HEM. Alcohol —*Daylight*—bluish-red solution with a yellow fluorescence.

HEM. Alcohol —*Ultraviolet* — brilliant reddish-orange fluorescence.

RHODAMINE B (*CI* 749)

Colour Index, Water —bluish-red solution with a strong fluorescence when dilute.

HEM. Water --*Daylight*—bluish-red solution with a strong (yellow) fluorescence when dilute.

HEM. Water —*Ultraviolet* — bright, reddish-orange fluorescence.

Colour Index, Alcohol —bluish-red solution with a strong fluorescence when dilute. The latter disappears on heating but returns on cooling.

HEM. Alcohol —*Daylight—cold alcohol*, bluish-red solution with a strong (orange) fluorescence when dilute. Fluorescence disappears when alcohol solution is heated to nearly boiling.

HEM. Alcohol --*Ultraviolet — cold alcohol*, brilliant, reddish-orange fluorescence. *Hot alcohol solution fluoresces brilliantly*, but the fluorescence is not so brilliant as that of a cold alcohol solution.

Colour Index —Dyes wool and silk from a neutral bath. Strong, bluish-red fluorescence.

HEM —*Daylight*—wool and silk exhibit a strong-bluish-red fluorescence.

HEM —*Ultraviolet*—wool, brilliant, orange fluorescence; silk, brilliant orange fluorescence.

Colour Index —Dyes cotton, mordanted with tannin and tartar emetic, bluish-pink without fluorescence, or oiled cotton bluish-pink with fluorescence.

HEM —*Daylight*—oiled cotton dyed with 0.25% Rhodamine B is a bluish-pink and exhibits daylight fluorescence when viewed through a wedge interference filter. It also exhibits a bright fluorescence in ultraviolet.

HEM —Dyeing is also visible-light fluorescent when examined in a visible light fluorescence box using Wratten filters #65 and #29.

RHODAMINE G (*CI* 750)

Colour Index, Water --Reddish-violet solution with a vermilion fluorescence.

HEM, Water --*Daylight*—reddish-violet solution with a vermilion fluorescence.

HEM, Water —*Ultraviolet* — reddish-orange fluorescence.

Colour Index, Alcohol --Reddish-violet solution with a vermilion fluorescence.

HEM, Alcohol --*Daylight*—reddish-violet solution with a vermilion fluorescence.

HEM, Alcohol —*Ultraviolet*—orange fluorescence.

Colour Index, H_2SO_4 Conc —Pale yellow solution, red fluorescent solution in dilution.

HEM, H_2SO_4 Conc —*Daylight*—pale yellow solution, no fluorescence in daylight.

HEM, H_2SO_4 Conc —*Ultraviolet*, bright, greenish fluorescence in ultraviolet.

Colour Index, H_2SO_4 Diluted —Red fluorescent solution.

HEM, H_2SO_4 Diluted —*Daylight*—solution turns red on dilution and has an orange fluorescence.

HEM, H_2SO_4 Diluted —*Ultraviolet*—orange fluorescence.

Colour Index --Dyes wool and silk from a neutral bath a fluorescent red, yellower than Rhodamine B (No. 749).

HEM —Wool and silk dyeings are a fluorescent pink in daylight.

HEM —*Daylight*—dyeings are *daylight fluorescent* when viewed through an interference filter.

RHODAMINE 3B (*CI* 751)

Colour Index, Water —violet-red solution with a brownish-red fluorescence when in very dilute solution.

HEM, Water —*Daylight*—violet-red solution with a yellowish-red fluorescence when in dilute solution.

HEM, Water —*Ultraviolet*—scarlet fluorescence.

Colour Index, Alcohol —Red solution with a vermilion fluorescence.

HEM, Alcohol —*Daylight*—red solution with a vermilion fluorescence.

HEM, Alcohol --*Ultraviolet*—scarlet fluorescence.

Colour Index —Dyes silk red with a yellowish-red fluorescence.

HEM —*Daylight*—dyes silk red with a yellowish-red fluorescence. Silk dyeing is daylight fluorescent when viewed through a wedge interference filter.

HEM —Silk dyeings are visible-light fluorescent.

RHODAMINE 6G (*CI* 752)

Colour Index, Water —Readily soluble with a scarlet-red color and a greenish fluorescence.

HEM, Water —*Daylight*—scarlet-red solution with a greenish fluorescence.

HEM, Water —*Ultraviolet*—yellowish-orange fluorescence.

Colour Index, Alcohol —Red solution with a yellow fluorescence.

HEM, Alcohol —*Daylight*—red solution with a greenish-yellow fluorescence.

HEM, Alcohol —*Ultraviolet* — reddish-yellow fluorescence.

Colour Index —Dyes acetyl-silk (cellulose acetate—HEM) pink with a marked yellow fluorescence.

HEM	—Dyes cellulose acetate pink with a marked yellow fluorescence in daylight. When viewed through a wedge interference filter, the dyeing is daylight fluorescent.
HEM	—Examined in ultraviolet, the dyeing is brilliantly fluorescent with a golden-yellow color.

IRISAMINE G (*CI* 753)

Colour Index, Water	—Crimson-red solution with a brown fluorescence.
HEM, Water	—*Daylight*—crimson-red solution with a brown or smoky-orange fluorescence.
HEM, Water	—*Ultraviolet* — reddish-orange fluorescence.
Colour Index, Alcohol	—Scarlet-red solution with a green fluorescence.
HEM, Alcohol	—*Daylight*—scarlet-red solution with a yellow fluorescence.
HEM, Alcohol	—*Ultraviolet*—bright orange fluorescence.
Colour Index	—Dyes silk bright red with a bluish-red fluorescence.
HEM	—Dyes silk bright red with a yellowish-red fluorescence in *daylight*.
HEM	—Silk dyeings are *daylight fluorescent* when viewed through a wedge interference filter.
HEM	—*Ultraviolet* — silk dyeings fluoresce bright orange in contrast to the bluish-red shade observed in daylight.

FAST ACID EOSINE G (*CI* 756)

Colour Index, Water	—Yellowish-red solution with a strong green fluorescence.
HEM, Water	—*Daylight*—yellowish-red solution with a strong greenish-yellow fluorescence.
HEM, Water	—*Ultraviolet*—brilliant yellowish-orange fluorescence.
Colour Index, H_2SO_4	—Yellow solution with a faint green fluorescence, reddish-yellow solution and then pink solution with a green fluorescence on dilution.
HEM, H_2SO_4 Conc	—*Daylight*—yellow solution with a faint green fluorescence.
HEM, H_2SO_4 Conc	—*Ultraviolet*—bright yellow fluorescence —*not green*.
HEM, H_2SO_4 Diluted	—*Daylight*—reddish-yellow solution with a greenish-yellow fluorescence.
HEM, H_2SO_4 Diluted	—*Ultraviolet* — bright, greenish-yellow fluorescence.
HEM, H_2SO_4 Diluted further	—*Daylight*—pink with a green fluorescence.
HEM, H_2SO_4 Diluted further	—*Ultraviolet* — bright, greenish-yellow fluorescence.

CHROMORHODINE B (*CI* 762)

Colour Index, Water	—Cherry-red solution with a strong yellow fluorescence.
HEM, Water	—*Daylight*—cherry-red solution with a yellow fluorescence.
HEM, Water	—*Ultraviolet* — bright, orange, fluorescence.
Colour Index, Water and HCl	—the fluorescence disappears.
HEM, Water and HCl	—*Daylight*—shade changes yellower and most of the fluorescence disappears.
HEM, Water and HCl	—*Ultraviolet*—solution has a bright, reddish-orange fluorescence which is slightly duller than that of the water-only solution. It definitely fluoresces in ultraviolet.
Colour Index, H_2SO_4 Conc	—Lemon-yellow solution with a green fluorescence, orange-red solution and then pink solution on dilution.
HEM, H_2SO_4 Conc	—*Daylight*—lemon-yellow solution with a green fluorescence.
HEM, H_2SO_4 Conc	—*Ultraviolet* — bright, greenish-yellow fluorescence.
HEM, H_2SO_4 Diluted	—*Daylight*—red solution with a slight greenish fluorescence.
HEM, H_2SO_4 Diluted	—*Ultraviolet* — bright, greenish-yellow fluorescence.
HEM, H_2SO_4 Diluted further	—*Daylight*—pink solution with a slight yellow fluorescence.
HEM, H_2SO_4 Diluted further	—*Ultraviolet* — greenish-yellow fluorescence.

URANINE (*CI* 766)

Colour Index, Water	—Yellow solution with an intensely green fluorescence which is visible in extreme dilution, for 1 part of Fluorescein (HEM-Uranine) is sufficient to impart a distinct fluorescence to 40 million parts of water.
HEM, Water	—*Daylight*—yellow solution with an intensely green fluorescence which is visible in extreme dilution. Water solution has a more brilliant *daylight* fluorescence than the alcohol solution.
HEM, Water	—*Ultraviolet*—extremely brilliant greenish-yellow fluorescence.
Colour Index, Alcohol	—Readily soluble.
HEM, Alcohol	—*Daylight*—yellowish solution with an intensely green fluorescence.
HEM, Alcohol	—*Ultraviolet*—extremely brilliant yellow fluorescence.
Colour Index, NaOH	—Darker solution with a dark green fluorescence.
HEM, 20% NaOH Solution	—*Daylight*—golden-yellow solution with a dark green fluorescence.
HEM, 20% NaOH Solution	—*Ultraviolet* — brilliant greenish-yellow fluorescence.
Colour Index, H_2SO_4 Conc	—Yellow solution with a very faint fluorescence. Yellow solution and then yellow precipitate on dilution.
HEM, H_2SO_4 Conc	—*Daylight*—very light yellow with a very faint (green) fluorescence.
HEM, H_2SO_4 Conc	—*Ultraviolet* — bright greenish-yellow fluorescence.

CHRYSOLINE (*CI* 767)

Colour Index, Water	—Brown solution with a green fluorescence.
HEM, Water	—*Daylight*—brownish solution (could be called a brownish-orange) with a strong green fluorescence.
HEM, Water	—*Ultraviolet* — greenish-yellow fluorescence.
Colour Index, Alcohol	—No data.
HEM, Alcohol	—*Daylight*—yellow shade with a strong greenish fluorescence.

HEM, Alcohol —*Ultraviolet* — bright, greenish-yellow fluorescence.

EOSINE YS (*CI* 768)

Colour Index, Water —Soluble in 3 parts with a bluish-red color, the diluted solution has a green fluorescence.

HEM, Water —*Daylight* — brownish-orange solution with a green fluorescence.

HEM, Water —*Ultraviolet*—bright yellow fluorescence.

Colour Index, HCl to aqueous solution —Yellowish-red precipitate of the color acid, soluble in alcohol with a reddish-yellow color and no fluorescence.

HEM, HCl to aqueous solution —*Daylight* — a copious yellowish-red precipitate forms. Filter precipitate, dissolve in alcohol, which produces a reddish-yellow solution without fluorescence in daylight.

HEM, Alcohol solution of precipitate —*Ultraviolet*—solution has a bright orange fluorescence with a greenish suffusion.

Colour Index, Alcohol —Bluish-red solution with a yellowish-green fluorescence.

HEM, Alcohol —*Daylight*—bluish-red solution with a yellowish-green fluorescence.

HEM, Alcohol —*Ultraviolet* — brilliant yellow fluorescence.

SPIRIT EOSINE (*CI* 770)

Colour Index, Water —Very sparingly soluble cold, more readily soluble with a cherry-red color and faint greenish-yellow fluorescence on boiling.

HEM, Water —*Daylight*—Very sparingly soluble cold, with a pink color and greenish-yellow fluorescence, more readily soluble with a cherry-red color and a greenish-yellow fluorescence on boiling.

HEM, Water —*Ultraviolet*—a greenish-yellow fluorescence on the cold sample and a golden-yellow fluorescence with the hot solution.

Colour Index, Alcohol —Slightly soluble with a red color and a brownish-yellow fluorescence.

HEM, Alcohol —*Daylight*—red solution with an orange-yellow fluorescence.

HEM, Alcohol —*Ultraviolet*—a bright, yellowish-orange fluorescence.

Colour Index —Dyes silk yellowish-red with a faint fluorescence.

HEM —*Daylight*—dyes silk pink with a yellowish-red fluorescence. Dyes wool red with a yellowish-red fluorescence. Dyes nylon deep yellowish-red with a yellowish-red fluorescence.

HEM —*Ultraviolet* — silk — light pink fluorescence. Wool—yellowish-orange fluorescence. Nylon—brilliant yellowish-orange fluorescence.

ERYTHROSINE (*CI* 772)

Colour Index, Water —Cherry-red solution without fluorescence.

HEM, Water —*Daylight*—cherry-red solution without fluorescence.

HEM, Water —*Ultraviolet*—moderately bright yellow fluorescence.

Colour Index, Alcohol —No data given.

HEM, Alcohol —*Daylight*—red solution with a yellow fluorescence.

HEM, Alcohol —*Ultraviolet*—moderately bright, yellowish-orange fluorescence.

ERYTHROSINE 3B (*CI* 773)

Colour Index, Water —Cherry-red solution without fluorescence.

HEM, Water —*Daylight*—cherry-red solution with a faint greenish fluorescence.

HEM, Water —*Ultraviolet* — bright, reddish-orange fluorescence.

Colour Index, Alcohol —No data given.

HEM, Alcohol —*Daylight*—red solution with a yellow fluorescence.

HEM, Alcohol —*Ultraviolet*—yellowish-orange fluorescence.

PHLOXINE B (*CI* 774)

Colour Index, Water —Cherry-red solution with a greenish-yellow fluorescence.

HEM, Water —*Daylight*—cherry-red solution with a dull greenish fluorescence.

HEM, Water —*Ultraviolet* — bright, reddish-orange fluorescence.

Colour Index, Alcohol —No data given.

HEM, Alcohol —*Daylight*—red solution with a yellow fluorescence.

HEM, Alcohol —*Ultraviolet* — bright, scarlet fluorescence.

Colour Index —Dyes wool from an acetic acid bath bluish-red without fluorescence.

HEM —*Daylight*—dyed on wool from an acetic acid bath, bluish-red without definite fluorescence in daylight.

HEM —*Ultraviolet*—when examined in ultraviolet light, dyeings on wool exhibit moderate to bright fluorescence, depending upon the depth of shade.

ROSE BENGAL BTO (*CI* 777)

Colour Index, Water —Readily soluble with a cherry-red color and no fluorescence.

HEM, Water —*Daylight*—cherry-red solution and no fluorescence.

HEM, Water —*Ultraviolet* — medium bright scarlet fluorescence.

Colour Index, Alcohol —No data given.

HEM, Alcohol —*Daylight*—cherry-red solution with a slight yellow fluorescence.

HEM, Alcohol —*Ultraviolet*—bright scarlet fluorescence

Colour Index —Dyes wool from an acid bath and silk from a soap bath bluish-red without fluorescence.

HEM —*Daylight*—dyes wool bluish-red from an acid (acetic acid) bath without fluorescence in daylight.

HEM —*Ultraviolet*—fluoresces a bluish-pink.

HEM —*Daylight*—dyes pure silk a bluish-red from an acid (acetic acid) bath without fluorescence in daylight.

HEM —*Ultraviolet* — the dyeing exhibits a moderately bright, bluish-red fluorescence.

PHLOXINE B (*CI* 778)

Colour Index, Water —Readily soluble with a bluish-red color and a faint dark green fluorescence.

HEM, Water —*Daylight*—bluish-red solution with a slight greenish fluorescence.

HEM, Water —*Ultraviolet*—bright orange fluorescence.
Colour Index, Alcohol —Bluish-red solution with a brick-red fluorescence.
HEM, Alcohol —*Daylight*—red solution with a brick-red fluorescence.
HEM, Alcohol —*Ultraviolet* — brilliant scarlet fluorescence.

ROSE BENGAL (*CI* 779)

Colour Index, Water —Bluish-red solution without fluorescence.
HEM, Water —*Daylight*—bluish-red solution without fluorescence.
HEM, Water *Ultraviolet* — moderately bright red fluorescence.

ACRIDINE YELLOW GR (*CI* 785)

Colour Index, Water —Yellow solution with a green fluorescence.
HEM, Water —*Daylight*—lemon-yellow solution with a green fluorescence.
HEM, Water —*Ultraviolet* — bright, greenish-yellow fluorescence.
Colour Index, Alcohol —Yellow solution with a green fluorescence.
HEM, Alcohol —*Daylight*—yellow solution with a green fluorescence.
HEM, Alcohol —*Ultraviolet* — brilliant greenish-yellow fluorescence.

CORIOPHOSPHINE O (*CI* 787)

Colour Index, Water —Orange-yellow solution with a yellowish-green fluorescence which is increased by the addition of alcohol.
HEM, Water —*Daylight*—orange-yellow solution with a yellowish-green fluorescence which is greatly increased by an addition of alcohol.
HEM, Water —*Ultraviolet*—dull, greenish-yellow fluorescence.
HEM, Water solution + alcohol —*Ultraviolet* — bright, greenish-yellow fluorescence.

EUCHRYSINE 3R (*CI* 788)

Colour Index, Water —Orange-yellow solution with a green fluorescence.
HEM, Water —*Daylight*—orange-yellow solution with a green fluorescence.
HEM, Water —*Ultraviolet*—medium bright, greenish-yellow fluorescence.
Colour Index, Alcohol —Orange-yellow solution with a green fluorescence.
HEM, Alcohol —*Daylight*—yellow solution with a green fluorescence.
HEM, Alcohol —*Ultraviolet* — bright, greenish-yellow fluorescence.
Colour Index, H_2SO_4 Conc —Almost colorless solution with a green fluorescence. Red solution and then orange-yellow solution on dilution.
HEM, H_2SO_4 Conc —*Daylight* — almost colorless solution (tinted yellow) with a green fluorescence.
HEM, H_2SO_4 Conc —*Ultraviolet*—bright, bluish-white fluorescence—*not green.*

ACRIDINE ORANGE 3R (*CI* 788)
ACRIDINE ORANGE 5R (*CI* 788)

Colour Index, Water —Orange-yellow solution with a green fluorescence.
HEM, Water —*Acridine Orange 3R—Daylight*—orange-yellow solution with a green fluorescence.
HEM, Water —*Acridine Orange 3R—Ultraviolet*—moderately bright, yellowish-orange fluorescence.
HEM, Water —*Acridine Orange 5R—Daylight*—orange-yellow solution with a green fluorescence.
HEM, Water —*Acridine Orange 5R—Ultraviolet*—moderately bright, yellowish-orange fluorescence.
Colour Index, Alcohol —Orange-yellow solution with a green fluorescence.
HEM, Alcohol —*Acridine Orange 3R—Daylight*—orange-yellow solution with a green fluorescence.
HEM, Alcohol —*Acridine Orange 3R—Ultraviolet*—brilliant yellow fluorescence.
HEM, Alcohol —*Acridine Orange 5R—Daylight*—orange-yellow solution with a green fluorescence.
HEM, Alcohol —*Acridine Orange 5R — Ultraviolet*—bright, reddish-yellow fluorescence.
HEM —Dyes silk from a soap bath orange with a greenish fluorescence in *daylight.* When examined in daylight through the wedge interference filter, the dyeing is *daylight fluorescent.*
HEM —*Ultraviolet*—silk dyeing fluoresces a bright, yellowish-orange.

BRILLIANT PHOSPHINE G (*CI* 789)

Colour Index, Water —Yellow solution with a green fluorescence when dilute.
HEM, Water —*Daylight*—yellow solution with a green fluorescence when dilute.
HEM, Water —*Ultraviolet*—moderately bright, greenish-yellow fluorescence.
Colour Index, Alcohol —Yellow solution with a green fluorescence.
HEM, Alcohol —*Daylight*—yellow solution with a green fluorescence.
HEM, Alcohol —*Ultraviolet*—bright, reddish-yellow fluorescence.
Colour Index, H_2SO_4 Conc —Yellow solution with a green fluorescence, brown solution and then yellow solution on dilution.
HEM, H_2SO_4 Conc —*Daylight* — yellow solution with a greenish fluorescence.
HEM, H_2SO_4 Conc —*Ultraviolet*—bright, golden-yellow fluorescence.

PHOSPHINE Y (*CI* 793)

Colour Index, Water —Reddish-yellow solution with a green fluorescence.
HEM, Water —*Phosphine Y—Daylight*—yellow solution with a green fluorescence.
HEM, Water —*Phosphine Y—Ultraviolet*—moderately bright orange fluorescence.
HEM, Alcohol —*Phosphine Y—Daylight*—yellow solution with a green fluorescence.
HEM, Alcohol —*Phosphine Y—Ultraviolet*—moderately bright orange fluorescence.
HEM, Water —*Phosphine GNC — Daylight* — reddish-yellow solution with a green fluorescence.
HEM, Water —*Phosphine GNC—Ultraviolet*—bright, yellow fluorescence.
HEM, Alcohol —*Phosphine GNC — Daylight* — reddish-yellow solution with a green fluorescence.

HEM, Alcohol —*Phosphine GNC—Ultraviolet*—bright, greenish-yellow fluorescence.

HEM, Water —*Phosphine 2RNC—Daylight*—reddish-yellow solution with a green fluorescence.

HEM, Water —*Phosphine 2RNC—Ultraviolet*—moderately bright, reddish-yellow fluorescence.

HEM, Alcohol —*Phosphine 2RNC—Daylight*—reddish-yellow solution with a green fluorescence.

HEM, Alcohol —*Phosphine 2RNC—Ultraviolet*—bright, yellowish-orange fluorescence.

Colour Index, H_2SO_4 Conc —Light, reddish-yellow solution with a green fluorescence; deep, reddish-yellow solution on dilution.

HEM, H_2SO_4 Conc —*Phosphine Y—Daylight*—light, reddish-yellow solution.

HEM, H_2SO_4 Conc —*Phosphine Y — Ultraviolet* — bright, green fluorescence.

HEM, H_2SO_4 Conc —*Phosphine GNC—Daylight*—light, reddish-yellow solution with a green fluorescence.

HEM, H_2SO_4 Conc —*Phosphine GNC—Ultraviolet*—bright, smoky-yellow fluorescence.

HEM, H_2SO_4 Conc —*Phosphine 2RNC — Daylight* — light, reddish-yellow solution with a green fluorescence.

HEM, H_2SO_4 Conc —*Phosphine 2RNC—Ultraviolet*—moderately bright, smoky-yellow fluorescence.

PHOSPHINE 4G (*CI* 794)

Colour Index, Water —Brownish-orange solution.

HEM, Water —*Daylight*—dull orange with a green fluorescence.

HEM, Water —*Ultraviolet* — yellowish-green fluorescence.

Colour Index, Alcohol —Orange-yellow solution with a strong green fluorescence.

HEM, Alcohol —*Daylight*—green fluorescence.

HEM, Alcohol —*Ultraviolet* — bright, yellowish-green fluorescence.

Colour Index, H_2SO_4 Conc —Dark, yellowish-brown solution with a strong green fluorescence, yellowish-orange solution on dilution.

HEM, H_2SO_4 Conc —*Daylight*—brown solution without fluorescence.

HEM, H_2SO_4 Conc —*Ultraviolet* — bright yellowish-green fluorescence.

HEM, H_2SO_4 Diluted —*Daylight* — orange solution with a greenish fluorescence.

HEM, H_2SO_4 Diluted —*Ultraviolet*—dull greenish-yellow fluorescence.

HEM, H_2SO_4 Diluted further —*Daylight* — orange solution with a greenish fluorescence.

HEM, H_2SO_4 Diluted further —*Ultraviolet*—moderately bright golden-yellow fluorescence.

EUCHRYSINE 2G (*CI* 797)

Colour Index, Water —Yellow solution.

HEM, Water —*Daylight*—yellow solution with a green fluorescence.

HEM, Water —*Ultraviolet*—bright green fluorescence.

Colour Index, Alcohol —Yellow solution with a green fluorescence.

HEM, Alcohol —*Daylight*—yellow solution with a green fluorescence.

HEM, Alcohol —*Ultraviolet* — brilliant, greenish-yellow fluorescence.

Colour Index, H_2SO_4 Conc —Yellow solution with a strong green fluorescence. Reddish-yellow solution on dilution.

HEM, H_2SO_4 Conc —*Daylight*—greenish fluorescence.

HEM, H_2SO_4 Conc —*Ultraviolet*—bright green fluorescence.

HEM, H_2SO_4 Diluted —*Daylight*—deeper yellow solution on dilution with a greenish fluorescence.

HEM, H_2SO_4 Diluted —*Ultraviolet*—bright yellow fluorescence.

CORIOFLAVINE G (*CI* 799)

Colour Index, Water —Orange-brown solution.

HEM, Water —*Daylight*—orange-brown solution without fluorescence.

HEM, Water —*Ultraviolet*—bright green fluorescence.

Colour Index, Alcohol —Yellowish-brown solution.

HEM, Alcohol —*Daylight* — yellowish-brown solution, green fluorescence.

HEM, Alcohol —*Ultraviolet* — bright, greenish-yellow fluorescence.

Colour Index, H_2SO_4 Conc —Yellow solution with a strong green fluorescence. Brown solution and then orange-brown solution on dilution.

HEM, H_2SO_4 Conc —*Daylight*—yellow solution with a strong green fluorescence.

HEM, H_2SO_4 Conc —*Ultraviolet* — medium bright smoky-yellow fluorescence.

PRIMULINE EXTRA (*CI* 812)

Colour Index, Water —Pale yellow solution with a blue fluorescence at great dilution.

HEM, Water —*Daylight*—pale yellow solution without blue fluorescence, even at great dilution.

HEM, Water —*Ultraviolet*—blue fluorescence at great dilution.

Colour Index, H_2SO_4 Conc —Pale yellow solution with a greenish fluorescence, orange-yellow precipitate on dilution.

HEM, H_2SO_4 Conc —*Daylight*—pale yellow solution with a blue fluorescence. At great dilution, no fluorescence and no orange-yellow precipitate.

HEM, H_2SO_4 Conc —*Ultraviolet* — bright blue fluorescence. At great dilution, a dull blue fluorescence.

THIOFLAVINE T (*CI* 815)
RHODULINE YELLOW T (*CI* 815)
METHYLENE YELLOW H (*CI* 815)

Colour Index, Water —Yellow solution.

HEM, Water —*Thioflavine T—Daylight*—yellow solution without fluorescence.

HEM, Water —*Thioflavine T—Ultraviolet*—moderately bright yellow fluorescence with a bluish suffusion.

HEM, Water —*Rhoduline Yellow 6G—Daylight*—yellow solution without fluorescence.

HEM, Water —*Rhoduline Yellow 6G — Ultraviolet* — yellow fluorescence with a blue suffusion.

HEM, Water —*Methylene Yellow H—Daylight*—yellow solution without fluorescence.

HEM, Water —*Methylene Yellow H—Ultraviolet*—yellow fluorescence with a blue meniscus.

Colour Index, Alcohol —Readily soluble with a yellow color and a green fluorescence.

HEM, Alcohol —*Thioflavine T—Daylight*—yellow solution and a green fluorescence.

HEM, Alcohol —*Thioflavine T—Ultraviolet*—moderately bright yellow fluorescence with a bluish suffusion.

HEM, Alcohol —*Rhoduline Yellow 6G—Daylight*—yellow solution with a green fluorescence.

HEM, Alcohol —*Rhoduline Yellow 6G — Ultraviolet* — moderately bright greenish-yellow fluorescence with a blue suffusion.

HEM, Alcohol —*Methylene Yellow H—Daylight* — yellow solution.

HEM, Alcohol —*Methylene Yellow H — Ultraviolet* — moderately bright yellow fluorescence with a blue meniscus.

Colour Index, H_2SO_4 Conc —Almost colorless solution with a dark green fluorescence, yellow solution on dilution.

HEM, H_2SO_4 Conc —*Thioflavine T—Daylight*—almost colorless solution without fluorescence.

HEM, H_2SO_4 Conc —*Thioflavine T — Ultraviolet* — dull blue fluorescence.

HEM, H_2SO_4 Conc —*Rhoduline Yellow 6G — Daylight* — almost colorless solution without fluorescence.

HEM, H_2SO_4 Conc —*Rhoduline Yellow 6G — Ultraviolet* — dull blue fluorescence.

HEM, H_2SO_4 Conc —*Methylene Yellow H — Daylight* — almost colorless solution without fluorescence.

HEM, H_2SO_4 Conc —*Methylene Yellow H—Ultraviolet*—dull yellow fluorescence.

HEM, H_2SO_4 Diluted —*Thioflavine T—Daylight*—yellow solution without fluorescence.

HEM, H_2SO_4 Diluted —*Thioflavine T — Ultraviolet* — dull blue fluorescence.

HEM, H_2SO_4 Diluted —*Rhoduline Yellow 6G—Daylight*—yellow solution without fluorescence.

HEM, H_2SO_4 Diluted —*Rhoduline Yellow 6G — Ultraviolet* — dull blue fluorescence.

HEM, H_2SO_4 Diluted —*Methylene Yellow H — Daylight* — yellow solution without fluorescence.

HEM, H_2SO_4 Diluted —*Methylene Yellow H—Ultraviolet*—dull blue fluorescence.

Colour Index —Dyes silk from a soap bath yellow with a green fluorescence.

HEM —*Daylight*—such silk dyeings are greenish-yellow in shade and have a green fluorescence in daylight. They are also daylight fluorescent when viewed through an interference wedge filter.

HEM —*Ultraviolet* — silk dyeings exhibit a bright, greenish-yellow fluorescence.

DIRECT BRILLIANT FLAVINE S (*CI* 816)

Colour Index, Water —Golden-yellow solution.

HEM, Water —*Daylight*—golden-yellow solution, faint greenish fluorescence.

HEM, Water —*Ultraviolet*—bright, blue fluorescence.

Colour Index, Alcohol —Less readily soluble than in water; yellow solution with a green fluorescence.

HEM, Alcohol —*Daylight*—yellow solution with a green fluorescence.

HEM, Alcohol —*Ultraviolet*—yellow with a smoky, bluish-gray fluorescence.

Colour Index, H_2SO_4 Conc —Brownish-yellow solution with a blue fluorescence, orange-yellow precipitate on dilution.

HEM, H_2SO_4 Conc —*Daylight* — brownish-yellow solution with a blue fluorescence.

HEM, H_2SO_4 Conc —*Ultraviolet*—bright, blue fluorescence.

INDULINE SCARLET (*CI* 827)

Colour Index, Water —Red solution.

HEM, Water —*Daylight*—red solution without fluorescence.

HEM, Water —*Ultraviolet* — medium-bright, crimson fluorescence.

Colour Index, Alcohol —Orange-red solution with a yellow fluorescence.

HEM, Alcohol —*Daylight*—orange-red solution with a yellowish-orange fluorescence.

HEM, Alcohol —*Ultraviolet* — bright, reddish-orange fluorescence.

SAFRANINE T CONC (*CI* 841)

Colour Index, Water —Red solution.

HEM, Water —*Daylight*—red solution without fluorescence.

HEM, Water —*Ultraviolet*—dull, red fluorescence.

Colour Index, Alcohol —Red solution with a yellowish-red fluorescence.

HEM, Alcohol —*Daylight*—red solution with a slight, yellowish-red fluorescence.

HEM, Alcohol —*Ultraviolet* — medium-bright, scarlet fluorescence.

IRIS VIOLET (*CI* 847)

Colour Index, Water —Reddish-violet solution.

HEM, Water —*Daylight*—reddish-violet solution without fluorescence.

HEM, Water —*Ultraviolet* — moderately bright cerise fluorescence.

Colour Index, Alcohol —Magenta-red solution with a bluish-red fluorescence.

HEM, Alcohol —*Daylight*—magenta-red solution with a bluish-red fluorescence.

HEM, Alcohol —*Ultraviolet* — bright, rich, crimson-red fluorescence.

NILE BLUE A (*CI* 913)

Colour Index, Water —Sparingly soluble cold, readily soluble hot, with a blue color.

HEM, Water —*Daylight*—blue solution without fluorescence.

HEM, Water —*Ultraviolet*—pink fluorescence.

Colour Index, Alcohol —Blue solution.

HEM, Alcohol —*Daylight*—blue solution without fluorescence.

HEM, Alcohol —*Ultraviolet*—pink fluorescence.

Colour Index, NaOH —Red precipitate—soluble in ether with a brownish-orange color and a green fluorescence.

HEM, NaOH —*Daylight*—red precipitate—soluble in ether with a slight green fluorescence.

HEM, NaOH —*Ultraviolet*—ether solution has a bright yellow fluorescence.

(concluded on page 459)

CHALLENGE TO RESEARCH BY WATER- AND AIR-POLLUTION PROBLEMS

RAYMOND W HESS

Coordinator of Pollution Research
National Aniline Division
Allied Chemical & Dye Corp

This paper was given by the author on May 15, 1956 before a meeting of the Western New York Section of the American Chemical Society.

At that time, Dr Hess was honored with the Jacob F Schoellkopf Award for his outstanding work in the field of air- and water-pollution control and abatement.

INTRODUCTION

FREQUENTLY all of us, especially the public, concerned with the problems of water and air pollution find ourselves in the dilemma of the motorist during the early days of touring when he might drive all night and end up in the place where he started, even though he had spent enough for gas to get somewhere. The basic reason for this dilemma is that there has been insufficient exploration and research to provide all the reliable road guides required for finding what we seek on this frontier of knowledge, and that we have failed to provide the public even with reliable road guides which are available for some of the areas.

My remarks are directed toward resolving this dilemma by extending the active interest of scientists and technologists in industry and research institutions, and their employers, individually and cooperatively, in the vast needs for research on water and atmospheric pollution problems, and in applying the results of this research to obtaining better understanding and support of legislatures, governmental agencies and the public in scientifically, economically and socially sound programs on pollution control.

During recent years large segments of the public have become fanatically disturbed about the implications of water and air pollution. Due to the pressures resulting from this concern practically every State, several groups of States in compacts or agreements, and the Federal government have enacted laws and regulations on the control of water pollution, and the treaty between the United States and Canada on the quality control of boundary waters has been activated. Each year many new bills are introduced into legislatures and several are enacted. Each year many supplementary regulations are drafted and some are adopted. The Federal government and four States have enacted laws, bills have been introduced in several more states, and local ordinances across the land are being strengthened, on the control of air pollution. These bills and regulations are descending on us like ticker tape showers but without any implications of honors being conferred.

Unfortunately, many of these pressures are not directed into channels which are scientifically, economically, and socially sound. Some of these channels lead to control of effluent regardless of their effects on water and the atmosphere in relation to man's uses—failing to recognize the cause-effect relationship, and failing to recognize that, within the framework of present or even visualized knowledge, it is neither practicable nor necessary to maintain all waters and the atmosphere in their natural states of quality.

It is very unfortunate, indeed, that many of these channels are misleading because of this country's trend toward being forced to spend billions of dollars without reaching the desired objectives of good health and good living consistent with other aspects of the age in which we live. For example, after industry has spent $35,000,000 in Los Angeles for installation of pollution abatement equipment, there seems to be some doubt as to the effectiveness of these expenditures since it was subsequently learned that domestic burning of rubbish and automotive exhausts are major factors in the smog problems in that area. These pressures for large expenditures are increasing at an accelerating rate. This trend indicates that the bottom of the financial barrel has barely been wetted by the hundreds of millions of dollars which are being spent each year in the name of pollution control. Even this simile does not give an adequate comparison since the barrel seems to be made of political rubber having infinite elasticity.

It is generally accepted by serious students of these problems that, within the scope of present and even visualized knowledge, it is neither practicable nor necessary to good health, good living and sound economy of the country to prevent much of man's wastes from reaching waters and the atmosphere, as the country becomes more densely populated and highly industrialized. It is not practicable because of the unbearable economic burden on the country which would be incurred. It is no more practicable than it is to stop production of necessities. The enormity of the problem is reflected by recalling that the sources of these wastes are not only homes, factories, commerce, governmental and private institutions but also mine drainage and the land from which cultivation practices send soil, insecticides and fungicides into public waters and the atmosphere. Hundreds of millions of dollars are being expended each year on control of wastes at these sources and, yet this is only the beginning.

It is not necessary to prevent all of man's wastes from reaching public waters and the atmosphere because segments of these resources, even though not naturally suitable for all of man's uses, have capacities for regaining their natural states of quality in many respects before reaching another segment. This leads to the economic concept that it is not necessary to maintain all segments in their natural states of quality for all of man's uses. Furthermore, it is not necessary because some of man's additions are known to improve the quality of these resources for certain uses. It is no more necessary than it is to stop drinking coffee, coca cola and cocktails because they are polluted to such an extent that fish cannot survive in them. Current habits suggest that most people would like to have rivers of coffee running past their homes and places of work even though they could not use them for fishing, and are merely choosy about the kind of polluted air they breath.

These concepts, however, do not dispose of the pollution problem. They merely dispel some of the dense smog, due to the smoke of vituperation and

the fogs of ignorance, enabling us to see better the nature of the problem and points of intelligent approaches to its solution. We find many gaps in our knowledge of the sciences of waters and the atmosphere in relation to their self-purification processes, of the effects of a multitude of different types of wastes on the qualities of water and the atmosphere in relation to man's many uses of them, of efficient and economically sound methods for diverting many wastes from waters and the atmosphere, and of the many indispensably related analytical methods.

Filling these gaps is an adventuresome but a grave challenge to the highest qualities of research talent.

RESEARCH NEEDED ON SCIENCES OF WATER & THE ATMOSPHERE

Let us first take a glimpse at what is known and what else needs to be known about the sciences of water and the atmosphere.

Nature's waters of so-called "pristine purity" contain a myriad of plant and animal life, decaying plant and animal tissues, suspended solids of many kinds, and a large variety of dissolved solids and gases. Some of these are continually being fed into the water by the soil and atmosphere and then form new chemicals and biota by chemical and biodynamic processes.

Some of these natural components and processes are favorable to some of man's uses but unfavorable to other uses. Dissolved oxygen is essential to fish life and nature's water purification processes but unfavorable to industrial cooling because of contributing to corrosion of equipment. Calcium salts are favorable to health, the propagation of shell fish, and to reducing the toxicities of some substances but injurious to steam boilers and to cleansing operations using soap. Sodium chloride in sea water concentrations is favorable to propagation of shell fish but is unfavorable to fresh water fish, drinking, and most industrial uses. Domestic wastes supply food for fish but are a menace to human health. Algae aid nature's water purification processes in some respects, and serve as food for fish but sometimes impart toxicities and obnoxious tastes to water, and are nuisances for other uses. Iron and sulfur compounds are thought by some to impart healthful properties to bath waters but are generally regarded as nuisances or harmful to water supplies for all other uses. Nitrates may be of some use to nature's processes but their presence in well water have been known to cause infant mortality. All of nature's impurities are injurious to boiler waters and to some chemical processes, but pure water is not palatable.

Even though various waters differ somewhat from each other in these respects, notably fresh water in comparison with sea water, nature's processes hold the composition of a given stream or body of water essentially the same, except for temporary fluctuations, despite the constant feeding of chemicals and organisms from the soil and atmosphere, and despite feeding of limited amounts by man's operations. Organic substances are oxidized, for the most part, to carbon dioxide and water by biochemical processes. Even taste producing and toxic substances, such as phenols and cyanides, are eventually destroyed by biochemical oxidation. Acids are neutralized and toxic heavy metals are precipitated by natural alkalinity. Even pathogenic organisms are eventually destroyed. In many cases mere dilution reduces components to harmless concentrations. These phenomena are generally referred to as water's self-purification processes.

Nature's inability to do anything about sodium chloride, excepting by dilution, is a notable exception to water's ability to purify itself. Streams contain more calcium salts than sodium salts and yet the reverse is true for the oceans into which all streams discharge. Calcium salts are removed from sea water by organisms such as shell fish but sodium chloride gradually increases in concentration because of nature's inability to remove it.

Although much more than this is known about potomology and limnology, much more knowledge is needed to properly dispose of the wastes of man's operations which cannot be practicably avoided within the scope of present knowledge. These voids of knowledge call for seeking answers to the following questions, among many others, through research.

1) Are there substances, other than those known, which are injurious to biochemical purification processes?
2) Can substanees be added to nature's waters which will stimulate biochemical purification processes?
3) What can be done to waters to prevent the formation of objectionable tastes and odors due to natural causes?
4) What can be done to nature's waters to prevent heavy mortality of fish due to natural causes?
5) What are the effects of the uncontrolled violence of floods on water's self-purification processes?

It is a common observation that during some days visibility is very poor and the atmosphere may be annoying or irritating while during other days visibility is far reaching and the atmosphere appears to be pure and invigorating, even though the amounts of smoke and other wastes discharged remain the same. It is also a common observation that the average quality of the atmosphere varies greatly from one locality to another even though the amounts and kinds of wastes discharged, and the conditions of their discharge are essentially the same. Scientists know that these variations in atmospheric quality in the same and different localities are due to variations in meteorological conditions. It follows from these observations that there are no simple relationships between the discharge of wastes and atmospheric pollution.

Although much has been learned about the effects of variations of meteorological conditions much remains to be learned through research before scientifically, economically and socially sound programs for air pollution control can be established. Accordingly, it is proposed that more knowledge of the following, among others, is needed.

1) Factors which affect the natural cleaning processes of the atmosphere.
2) Effects of nature's radiant energies on reactions between contaminants with each other, and with atmospheric oxygen and water.
3) Relationship of inversions, turbulence, humidity, diffusion, eddies, temperature and topography as aspects of meteorological conditions.

RESEARCH NEEDED ON WATER AND ATMOSPHERIC QUALITY INDICES

Next, let us consider briefly the needs for research on methods for determining the extent of wastes treatment required.

Efforts are made to express the quality of water in physical, chemical and biological terms. Concentration limits for individual wastes for various uses of water, are indicated as maxima. Concentration limits for acids and alkalies, which are expressed as pH values, are indicated as both maxima and minima. Concentration limits for dissolved oxygen, a natural component of water which is consumed by wastes, are indicated as

minima. These concentrations vary for different uses.

Although there is considerable confusion as to just what is meant when the words "standards," "objectives," or "criteria" are used, the word "standards" for these concentrations, when expressed numerically, it seems is frequently taken to mean exact values for the same use of water in different areas, regardless of other considerations, failure of which to meet is violation of law or regulations. The word "objectives" it seems is usually taken to mean exact requirements which are aimed at and should be met eventually. The word "criteria" in this connection seems generally to be used to mean guides toward apparent requirements which may be altered as more exact knowledge of them becomes available. I choose to use the word indices of quality for the purpose of having an expression, referring to concentration limits, as guides without reference to rigidity or flexibility of their application to water pollution control, discussion of which may throw light on the needs for flexibility and for much more research toward making them more useful and equitable.

During recent years the characteristics of water biota also are coming to be used as indices of water quality.

Concentration limits for many substances in relation to water uses have been investigated. Different scientists have arrived at considerably different results for some substances. For example, currently there is a controversy over the threshold concentration for taste of phenol in water supplies, even though this has been investigated extensively. Such differences could represent the difference between the economic success and failure of a production process having wastes.

Furthermore, tests have been made on very few mixtures, overlooking the effects of synergisms and antagonisms which set lower or higher limits than the sums of effects of all components would indicate. However, enough data are available to indicate that synergisms and antagonisms are very important. For example, it is known that cyanide is 1000 times more toxic at lower than at higher pH values. One investigator reports that fish survived four days in a hard water solution of chromic acid and only 30 minutes in a soft water solution at the same concentration. In contrast with this, ammonium sulfate is reported to be more toxic in hard than in soft water.

Obviously much more research is needed here to develop more reliable indices of water quality related to its uses.

The situation for indices of atmospheric quality are even less reliable than those for water quality. It is much more difficult in the laboratory to determine the effects of wastes in air on its inhabitants than effects of wastes in water on its inhabitants. Although there has been much research on this much more is needed. More is probably known about the effects of atmospheric contaminants on such things as the laundry, paints and vegetation but not much is known about allowable concentrations even in these respects.

Of this much we can be certain, these physical, chemical and biological indices of water and atmospheric quality in relation to their uses, will be used in some manner by governmental agencies. Accordingly, it is important that they be as reliable as possible in the interest of good health, good living, and economy.

RESEARCH NEEDED ON METHODS FOR WASTES CONTROL

Now, let us take a quick look at the needs for research on methods for wastes control.

Regardless of the type of pollution control in effect in various areas, whether it be guided by quality of receiving medium or effluent, the trend is toward higher pressures for wastes treatment as the country becomes more densely populated and highly industrialized. This can become an unnecessarily heavy economic burden on the country if not guided by adequate research on methods of pollution control.

Points of research attack for wastes control, in relation to the pollution problem, are threefold.

1) *Development of production processes which will give the minimum amounts of objectionable wastes* should be given first consideration. The researcher should start and continue toward this objective until he has exhausted every reasonable possibility of its attainment. This approach can result in a superior process and product or a cost advantage, or it may, at least, avoid costly treatment of wastes. One example of this was an organic chemical process in which phenol was used as an unconsumed flux. This material was removed from the product in the waste wash water. Extended research on process modifications eliminated the use of phenol, thereby avoiding the cost of its treatment, and gave a superior product at no increase in cost. The magnesium oxide process for paper production is another example of how research can alter a process to eliminate a water pollutant. The Raschig process for phenol suggests how research can avoid formation of a gaseous by-product. Many additional examples, in which advantages of varying degrees have been realized, could be cited. However, information on accomplishments in this category are confidentially restricted by a competitive market.

2) *The next point of attack for research is on the recovery and utilization or more economical disposal than would be possible without recovery.* Recovery and utilization, if not profitable, may prove to be the least costly method of avoiding pollution. Successful research and its application to recovery and profitable use of by-products from distillery and corn products industries are outstanding examples in this category which were stimulated by their constituting water pollution problems. Current research on recovery of Vitamin B12 from sewage sludge and use in stock feed is a trend toward making the treatment of municipal wastes less costly. Recovery of thousands of tons of hydrogen chloride from organic chemical chlorinations and conversion to muriatic acid for industrial use is an example of a profitable diversion of a gaseous by-product from the atmosphere. Recovery of sulfur from smelter fumes is another. Industry is doing much in this category but here again information available is confidentially restricted by a competitive market.

Nevertheless, the amounts of waste products are probably much greater than the amounts of materials which are produced for use. Frequently, research in this connection is not obviously attractive because of these by-products being in complex mixtures, available in only small amounts, or of questionable use. However, the necessity of diverting much of these wastes from public waters and the atmosphere calls for frequent reviews of the economic possibilities in recoveries through research as compared with the cost of treatment which yields no return.

3) *A great amount of research on methods for treating wastes is needed since practicable methods are either unknown or are very costly in most cases.* It is not likely that modification of production processes or recovery of by-products for use will solve nearly all of the pollution problems.

Even though methods for satisfactory treatment of domestic sewage are well established, they are inefficient and costly as compared with what might be some concepts of the imagination. Extensive research applying

knowledge of colloids, enzymes, supersonics, nuclear energy, radioactive tracers, and other disciplines, might result in great improvements.

Discharge of industrial wastes to municipal sewage treatment plants has possibilities of economic advantage because the presence of domestic wastes is often helpful to destruction of industrial wastes and avoids the cost of building and operating a separate plant. However, research should be undertaken in many cases to develop favorable conditions to make certain that industrial wastes would not be injurious to municipal installations and operations and to avoid incurring excessive service charges. Large volumes, large amounts of suspended solids, and high chlorine demand can make this method more expensive than separate treatment by other methods.

Chemical destruction, biochemical oxidation and combustion, are the principal methods for treatment of liquid industrial wastes separately which call for research. Much research toward making them more efficient and toward extending their application is needed.

One of the greatest difficulties is that in some plants there are many different types of wastes which, individually, are of no consequence to pollution. Collectively they are of considerable consequence, but it is not economically practicable to treat them separately and technically very difficult to treat them collectively, by either chemical or biochemical methods, because of their complexity. A chemical panacea for mixed inorganic wastes is needed. Biochemical methods for organic chemical wastes which will attack resistant components and withstand shock loadings, due to varying complexities of composition, are needed. Here, indeed, are great challenges to research.

A recent announcement that the Zimmerman process for using oxidation of paper sulfite waste liquors at high temperatures and pressures as source of heat is a stimulus to the imagination toward other possibilities through research.

The only practicable methods which are visualized at present for prevention of water pollution by brines from the chemical and petroleum industries are the current methods of regulated discharge into streams or subsurface injection.

Mine drainage, containing acid and iron, is a major water pollution problem in coal mining areas. Although extensive research on this problem has been under way for many years its solution is not yet in sight.

More research on treatment at water supply plants is needed for holding the cost of wastes treatment at a minimum by giving nature an opportunity to employ its self-purification processes.

Much additional research is also needed on methods for collecting or destroying dusts, fumes and gases to minimize atmospheric contamination. Care must be taken, however, not to convert an atmospheric pollution problem to a water pollution problem.

More research on land management practices is needed to develop methods for preventing harmful amounts of soil, insecticides and fungicides from reaching public waters and the atmosphere.

RESEARCH NEEDED ON ANALYTICAL METHODS

Finally let us get a glimpse of the needs for research on analytical methods.

Development of exact sciences of water and the atmosphere, of reliable indices of quality of water and the atmosphere, and of effective methods for treating wastes in relation to requirements of receiving media cannot be attained without having reliable analytical methods. Although much research has been applied to development of methods of analysis, much more research on these is needed. Many wastes are such complex mixtures of so many components that standard analytical methods for individual components, without modification, do not apply. In addition, these wastes contain many new by-products which must be identified before quantitative methods can be developed. Development of new techniques as well as application of combinations of all known techniques is needed. Coincident with these needs is the need for research on development of instruments to measure and record continuously the concentrations of water and air contaminants.

Although years have been given to development of methods for the commonly occurring wastes, phenols and cyanides in waste liquors and receiving waters, some people are convinced that the methods are not sufficiently accurate. After years of application by many investigators to the method for determining Biochemical Oxygen Demand there are still sharp differences of opinion as to its accuracy.

Current research on development of analytical methods for household detergents in water and sewage is an example of the type of application required. These wastes are being blamed for troubles in sewage plant operations, injury to streams, interference with water treatment processes and impairment of municipal water supplies. Although this is not a direct responsibility of manufacturers they are making an intensive investigation of these allegations and of methods for correction of any which can be supported by reliable data. The initial investigation showed that there are many substances in domestic wastes and in nature's drainage which can give similar troubles and which would be indicated to be detergents by available analytical methods.

The next step was to develop a reliable analytical method. After at least 25,000 man hours of expert research application by eight manufacturing companies and the U S Public Health Service a reliable analytical method for river water solutions of alkyl benzene sulfonate, the principal type of detergent, has finally been developed. This method is very complicated, involving carbon absorption, solvent extraction, chemical treatment and infrared techniques. The development of a method for this type of detergent in sewage is now under way, giving promise of being even more difficult and time consuming than that for detergent in river water because of the greater complexity of sewage.

Probably the most challenging needs for research on the air pollution analytical problems are in the techniques of representative sampling which now include probes, meters, suction devices, absorbers, adsorbers, condensation, sedimentation, impingement, filters, cyclones, thermal and electrical precipitators for aerosols, dusts, fumes, gases, vapors, mists and smogs. Since physical as well as chemical characteristics are of concern for some pollutants, one of the difficulties is to retain these physical characteristics during sampling. However, the techniques of spectroscopy, sonic absorption, thermal conductance, combustion, X-ray diffraction, polarography, chromatography, radioactive tracers and proton bombardment which are now applied to analysis of the samples suggest some of the complexities calling for further research on analytical methods.

RELATED CONSIDERATIONS

Although U S Public Health Service invites recommendation for research projects related to water and air pollution to be carried out either at its Robert A Taft Sanitary Engineering Center or at other research institutions with funds provided by the Public Health Service, there is such a tremendous number of time consuming problems, especially those with limited scope of application, that

(concluded on page 459)

Proceedings of the

American Association of Textile Chemists and Colorists

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JULY 2, 1956

Future Papers

Manuscripts of the following papers, all of which have been presented before local sections of AATCC, have been submitted to date to the publishers of American Dyestuff Reporter. Subject to the approval of the AATCC Publications Committee, all will appear in the Proceedings in future issues.

Authors and Section Officials are requested to inspect this list, and notify the publishers if there are any omissions.

"Chemical Considerations of Woolen and Worsted Finishing"—Herbert C Haller, Bernhard Altmann International Corp

"Some Aspects of the Newly Developed Crypto-Anionic Surface-Active Agent"—H G Seifert, Sandoz Chemical Works, Inc

"Hibulk Acrilan"—S Jack Davis, The Chemstrand Corp

"Arnel Triacetate—Its Properties, Applications and Dyeing Characteristics"—A F Tesi, Celanese Corp of America

"Cotton Finishing"—Hector C Borghetty, Rohm & Haas Co

"Arnel—1956"—Fred Fortess, Celanese Corp of America

"A Study of Wash and Wear Cottons"—Charles R Williams, Monsanto Chemical Co

"Aesthetic Standards in Textile Print Designs"—D D and Leslie Tillett, House of T Fabrics

"Wash and Wear Finishes on Cotton Fabrics"—Hector C Borghetty, Rohm & Haas Co

"Wash and Wear Fabrics"—E W Lawrence and R H Phillips, Cranston Print Works Co

"New Paper Products in Competition with Textiles"—Robert B Hobbs, National Bureau of Standards

"Current Developments in the Application of Dyestuffs"—L S Thompson, General Dyestuff Co

"A Study of the Destructive Action of Home Gas-Fired Dryers on Certain Dyestuffs"—Mid-West Section

PAINE TO SERVE AATCC AS EXECUTIVE SECRETARY

THE nomination of George Porter Paine to serve as executive secretary and assistant treasurer of AATCC was approved by the Council on June 15th by a unanimous vote.

Mr Paine will take office as soon after August 1st as he can relinquish his present duties as assistant secretary and director of public relations of the American Standards Association. On August 1st, Dr Harold C Chapin, who has served as secretary of AATCC for the past 23 years, will retire. Richard R Frey will continue as assistant secretary.

Mr Paine went with ASA after serving as an officer in the U S Navy during World War II. Prior to the war, he was a staff secretary of the National Association of Manufacturers.

He is 47 years old, married, and resides at 113 E 36th St, New York, N Y. His new duties will call for residence in the Lowell, Mass, area, site of AATCC headquarters.

Mr Paine is a member of the Trade Association Executives of New York and secretary of Organization Members of ASA, which comprises the staff heads of about 100 trade associations and technical societies. He is a member of the Naval Order of the United States, a member of the Military Order of the World Wars. He is a commander in the Naval Reserve.

AATCC Calendar

COUNCIL
Sept 12 (New York, N Y); Nov 16; Jan 18, 1957

NATIONAL CONVENTIONS
Sept 13-15, 1956 (Waldorf-Astoria, New York) (as part of the Perkin Centennial, Sept 10-15); 1957 (Boston); 1958 (Hotel Conrad Hilton, Chicago); 1959 (Washington, D C)

NORTHERN NEW ENGLAND SECTION
Sept 28 (Annual Outing—Wachusett Country Club, West Boylston, Mass); Oct 19 (Science Park, Boston, Mass); Dec 1 (Annual Meeting—Hotel Vendome, Boston)

PHILADELPHIA SECTION
Sept 28 (Abraham Lincoln Hotel, Reading, Pa); Nov 2 (Drake Hotel, Philadelphia, Pa); Dec 7 (Kugler's Restaurant, Philadelphia, Pa)

PIEDMONT SECTION
Oct 6 (Annual Meeting—Hotel Charlotte, N C)

RHODE ISLAND SECTION
Oct 18 (Johnson's Hummocks Grille); Dec 6 (Annual Meeting, Johnson's Hummocks Grille)

SOUTH CENTRAL SECTION
Dec 1 (Hotel Patten, Chattanooga, Tenn)

SOUTHEASTERN SECTION
Sept 22 (Columbus, Ga); Dec 8 (Atlanta, Ga)

WESTERN NEW ENGLAND SECTION
Oct 15 (Annual Meeting—Hartford, Conn); Nov 16 (Rapp's Restaurant, Shelton, Conn)

AATCC NEWSLETTER...

July 2, 1956

RESEARCH NEWS IN GENERAL:

At recent research committee meetings in New York, the Executive Committee on Research approved a suggestion that the AATCC Flammability Committee make a written analysis of the complete history of AATCC flammability tester, giving limitations, what it can do, etc, and that this write-up be circulated through ECR for checking, and then turned over to the National Fire Protective Association for study . . . Research budget for the 1956-1957 year was approved at $65,000 . . . Corporate Membership Committee reported revenue and number of corporate members higher this year than last indicating wider and growing support of AATCC research program . . . William D Appel reported to ECR on recent ISO meetings in England, noting a change in attitude toward test methods there, veering more to satisfying the present need for test methods, and recognizing that any methods promulgated now can be revised if future technology demands it . . . The ISO program for the week preceding the Perkin Centennial in September is completed, with colorfastness the subject on Wednesday through Friday, September 5-7, and Shrinkage and Laundering the subject of meetings of Friday, September 7, and possibly Saturday the 8th . . . Leonard Little also noted that plans for International Day, September 10, opening the Perkin Centennial Week, have been completed.

AT RESEARCH HEADQUARTERS IN LOWELL:

Constant increase in the use of the AATCC Accelerator for abrasion testing, and exploration of possibilities of developing a rapid shrinkage test for certain fabrics, has necessitated the purchase of a second instrument for use at Lowell. Researchers Harlan Glidden and Glenn Kidder are carrying out these projects . . . Dr Stiegler and George Mandikos attended two recent meetings on flammability—one at MIT and the second at the Statler Hotel in Boston. Latter meeting was under auspices of National Fire Protective Association . . . AATCC Blue Standards are being prepared for sale in 18- by 27-inch cuts; full particulars can be obtained by writing to Dr Stiegler at Lowell. . . . . AATCC Laboratory at Lowell has completed its part of the interlaboratory program comparing an alternative dynamic absorption test with the regular method. After all results have been reported by participating labs, complete evaluation will be made by the Committee. . . . Recent visitors to Lowell labs included ECR Chairman Charles Dorn and TCR Chairman Charles Sylvester.

COMMITTEE ACTIVITIES AND PERSONNEL:

Mrs Yvonne Chateauneuf has recently been added to Lowell staff in the capacity of laboratory assistant . . . Ernest Chornyei, of Bradford Dyeing Association, has joined TCR. . . . And Harold Wolf, of Forstmann Woolen Co, has been named chairman of the Committee on Evaluation of Fulling Agent. . . . Joseph Norton, of Atlas Electrical Devices Co, will succeed Robert Allison, of Giegy Co, Inc, as chairman of the Lightfastness Comittee . . . The Committee on Analysis of Fiber Mixtures has been made a reference committee . . . ERC will set up a small committee to study the use of radiant heaters in the textile industry, and possibly to develop a plan for AATCC research in this field . . . Ed Lawrence, of Cranston Print Works, will be chairman of this study committee.

Employment Register

This column is open for two insertions per year, per member, without charge. Blanks can be obtained from, and filed with, the secretary of the Association, Post Office Box 28, Lowell, Mass. It is understood that these will be open to inspection by prospective employers who can obtain further information from the secretary.

56-9

Education: Philadelphia Textile Inst, 3 years, general textile course

Experience: technical sales, textile chemicals

Age: 46; married; references; position in Carolinas or Southeast desired.

7-2, 7-16

56-10

Education: High school

Experience: Dyer and foreman, synthetics

Age: 48; married; references; South preferred.

7-2, 7-16

Rhode Island Section———

PRACTICAL INTERPRETATIONS OF THE RESULTS OF LABORATORY INVESTIGATIONS IN THE FIELD OF VAT PRINTING*

MAURICE R FOX

Arnold, Hoffman & Co, Inc, Providence, RI and Imperial Chemical Industries, Ltd, England

This paper describes how specific electronegative potentials are to be developed so that vat dyes will reduce under typical conditions obtaining when a print paste formulation is steamed. It indicates how minimum concentrations of reducing agent and alkali must be maintained in the print formula and it attempts to explain the behavior of glycerol. Some explanation is given of the behavior of different thickening agents with regard to visual yields.

INTRODUCTION

DURING the years 1937 to 1946, valuable technological studies on the subject of vat color printing were made and published by chemists with whom all printers in the state of Rhode Island are doubtless familiar. Specific reference is made to the names of Jacoby (*1*) and Glarum (*2*) and reference to the prize-winning papers produced by the R I Section for the Intersectional Contests of the AATCC in 1944 (*3*) and 1946 (*4*) cannot be omitted. Since this time it is fortunate that technical advance has continued and a review of some of the more recent thinking appears timely. The work carried out by Marshall, Peters, Michie and Thornton (*5, 6, 7, 8*) in England is particularly valuable, and it is upon their data that this paper is based. Any over-simplification of the complexity of the printers' art must be excused since the paper will only touch the fringe of the few of the many factors which control the success or failure of vat color printing. A systematic study of all the relevant factors can only proceed facet by facet and it will be very many years before all the various threads of investigation are woven to complete the final story, if indeed there is one.

An efficient reduction process is perhaps the major key to all successful vat dyeing and vat printing processes. The studies of Marshall and Peters (*5, 6*) have revealed that the wide variations which exist between the dyeing and printing behaviors of different vat dyes are largely attributable to the dominant factors of *redox potential* and *rate of reduction.*

REDOX POTENTIAL

The magnitude of redox potential determines the electronegative potential which must be developed before reduction of a vat dyestuff takes place in the print paste, or in the development liquor in the case of pad-steam or flash-age printing in the ager. The reducing chemicals must, therefore, develop (at some stage in the process —normally in the ager) a greater redox potential than that of the dyes being employed. Practical considerations limit the printer to choice of two reduction systems:

i) orthodox formulations based on sodium formaldehydesulfoxylate and an alkali carbonate, and

ii) formulations based on sodium hydrosulfite and caustic soda, ie, allied to dyeing techniques.

It has been shown that the reduction of vat dyes may be considered fundamentally as a transfer of electrons, and it can be measured in terms of the standard oxidation-reduction potential of the system. The determination of redox potential is an established physio-chemical technique and use is made of the potential developed at a bright platinum electrode immersed in the test solution. The practical significance of the redox potential, using a standard convention, is that the more negative the potential, the more difficult is the reduction and the stronger the reducing agent necessary. Vat dyes show a more or less strong electronegative potential, depending upon the nature of the system in which they are measured.

Marshall and Peters (*5*) first determined their redox potential data under idealized conditions (ie, in anhydrous pyridine at 20° C) and their rate of reduction measurements in dilute aqueous solutions at 40° and 60° C. This data could not be accurately extrapolated to supply the actual times for dyes to reduce in concentrated aqueous gum print pastes at steaming temperatures. It was also assumed in their early work that the critical redox potential corresponded to that of an average potash/sulfoxylate print paste by reference to technological data. Their latest work, however, reconciled this position by measurement of "leuco potentials" of vat dyes in aqueous systems. The direct measurement of reduction potentials of practical print pastes and correlation of these factors with printing behavior was then possible. The term "leuco potential" is defined as *the potential developed when a solution of leuco dye is oxidized to the point at which it is just saturated with the oxidized form* (see also (*9*)). The work clearly demonstrated that for a given electronegative potential in dilute solution, a greater potential is required in a print paste than in a dyebath. This confirmed the printers' normal experience that dyes with good dyeing properties will not necessarily print satisfactorily from a potash/sulfoxylate system. Table I shows some of these findings.

TABLE I

Dyestuff	Leuco potential: MV Dilute soln	Leuco potential: MV Printing paste
Caledon Yellow 5G (Pr 9)	−842	−979
Caledon Jade Green XN (*CI* 1101)	−815	−877
Durindone Scarlet Y (*CI* 1228)	−671	−734
Durindone Blue 4BC (*CI* 1184)	−646	−792

It has been known for many years that sodium formaldehydesulfoxylate is many times more stable than hydrosulfite. It is doubtful, however, if it has been fully appreciated that the stability of alkaline sulfoxylate and hydrosulfite solutions is determined

*Presented before the Rhode Island Section on October 13, 1955.

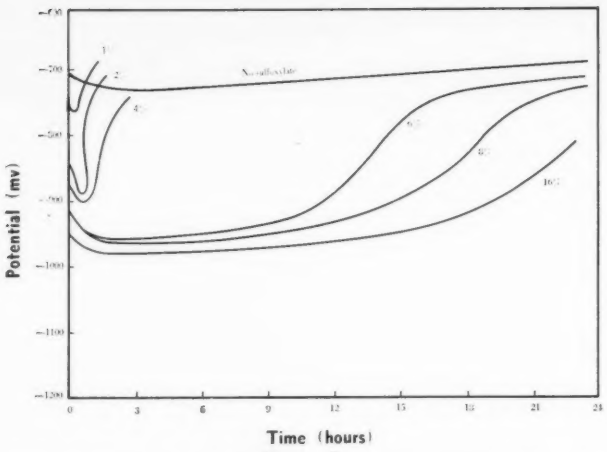

Figure 1
Rate of change of print pastes containing potassium carbonate and various concentrations of sulfoxylate. Temp: 98° C.

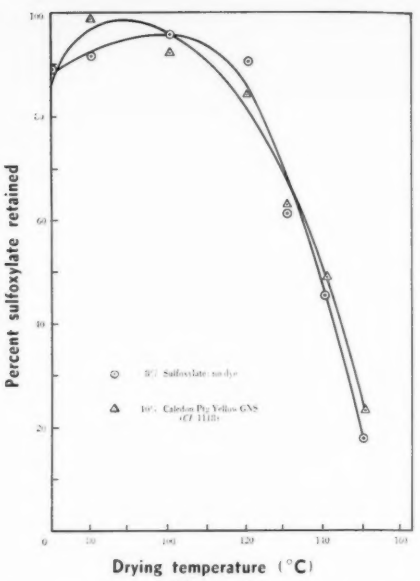

Figure 2
Decomposition of sulfoxylate on drying printed pattern for 3 minutes

very largely by their concentrations and to a smaller degree by the alkalinity.

The rise and decay of the reducing power of typical potash/sulfoxylate print pastes with time is shown in Figure 1.

In this graph, reducing power increases with increasing negative potential. It shows that all pastes examined display an initially very rapid increase in reducing power but then appreciable decay occurs as time proceeds, until reducing power falls to that of the printing gum alone. The maximum reducing power and the duration for which this is practically effective increases with increasing sulfoxylate concentration. Under the specific testing conditions used by Marshall & Peters (*6*) it is shown that with very low sulfoxylate concentrations, ie, up to 4%, the reducing action is merely transitory, but higher concentrations show an appreciably longer effective life. These factors have a very significant bearing on the practical problems of drying, storing and steaming of vat color prints. It will be readily appreciated that premature sulfoxylate deterioration can lead to inadequate reducing power for a given dye, with a consequent loss of tinctorial effect due to inadequate fixation.

Figure 2 illustrates the problems of maintaining sufficient sulfoxylate in the print paste throughout processing. The factor of maintaining a sufficiently high leuco potential throughout aging is one which must be stressed. Losses occur during storage, between drying and aging, but this curve (Figure 2) shows the drying effect where only approximately 20% of the original 8% sulfoxylate remains at the end of three minutes at 150° C. The amount of sulfoxylate retained, in this case approximately 1.5%, would supply sufficient reducing power for a few vat dyes only and anything requiring a higher potential than say — 800 mv would be inadequately fixed. Since each dye has a specific sulfoxylate demand, mixed dye formulations would lead to problems of shade control.

Prints, by merely hanging in the air, protected from light, can have sulfoxylate losses which have serious repercussions in mixture shades.

By way of illustration, we have prepared prints of Vat Jade Green (*CI* 1101) (— 877 mv) in conjunction with a) Vat Yellow GN (*CI* 1118) (— 753 mv) and b) Vat Flavone GC (Pr 9) (— 979 mv). Patterns of the resultant greens were aged immediately after drying and also after 24, 48 and 72 hours air hanging. The sulfoxylate losses due to delay between drying and aging were clearly evident in the case of the Jade Green/Yellow GN mixture in complete lack of fixation of the Jade Green after 48 hours air hanging. Yellow GN, with its low electronegative potential demand continues to be fixed with even traces of remaining sulfoxylate. With the Jade Green/Flavone mixture only the Jade Green portion is fixed after 48-72 hours hanging since the retained sulfoxylate concentration has only the power to fix the dye with the lower potential and insufficient remains to reduce the Flavone GC with its demand for — 979 mv.

Temperature has a relatively minor effect on the rate of sulfoxylate decay in the actual print paste but the alkali used has a more profound effect. Caustic soda produces a higher electronegative potential with both sulfoxylate and hydrosulfite than does potassium carbonate, but at the same time caustic soda gives rise to an increased decay rate. Some of the effects of thickeners, reducing agents and alkalies studied by Marshall & Peters are shown in Table II.

The range of potentials the printer requires for the application of vat dyes is from approximately — 734 mv to — 979 mv, and from the data given in Table II it appears that there will be no problem to supply this requirement.

TABLE II

Thickening	Alkali	Reducing Agent	Potential (MV)
Gum tragacanth	13.5% K_2CO_3	Nil	−720
British gum	13.5% K_2CO_3	Nil	−724
British gum	13.5% K_2CO_3	1% $NaHSO_2 \cdot CH_2O$	−757
British gum	13.5% K_2CO_3	8% $NaHSO_2 \cdot CH_2O$	−960
Gum tragacanth	13.5% K_2CO_3	8% $NaHSO_2 \cdot CH_2O$	−980
British gum	8.0% NaOH	2% $NaHSO_2 \cdot CH_2O$	−980
British gum	8% NaOH	8% $NaNSO_2 \cdot CH_2O$	−1082
British gum	13.5% K_2CO_3	8% $Na_2S_2O_4$	−1025
British gum	8.0% NaOH	2% $Na_2S_2O_4$	−1030

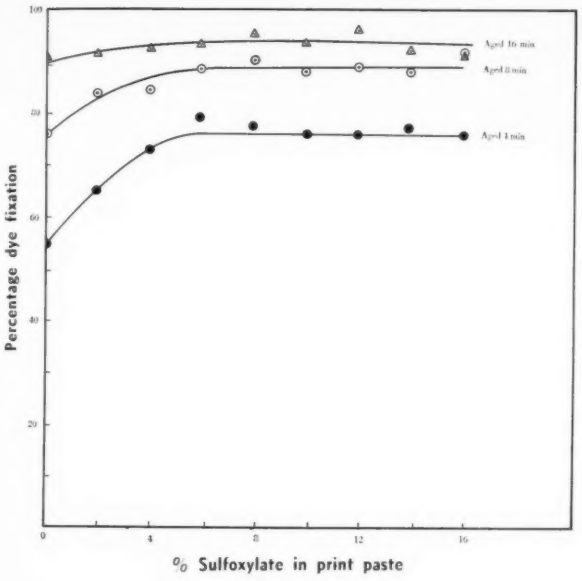

Figure 3
10% Caledon Ptg Yellow GNS (*CI* 1118)
Leuco potential = −753 mv
$T_{0.5}$ = 5 sec

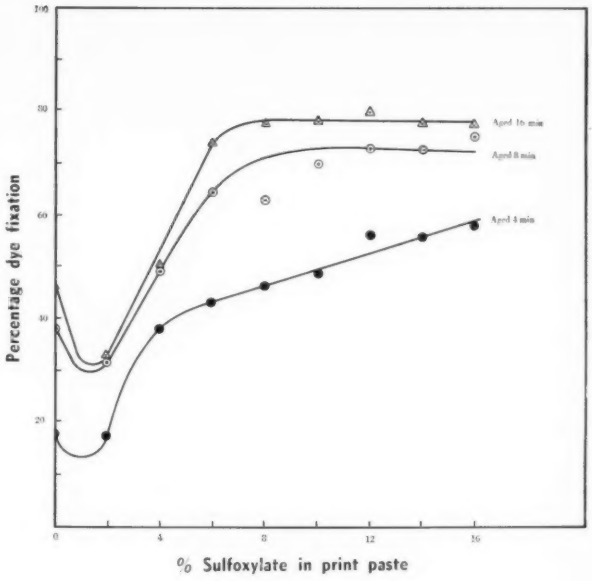

Figure 4
10% Duridone Ptg Brown GS (Pr 121)
Leuco potential = −817 mv
$T_{0.5}$ = 30 sec

In considering this data, however, it must be stressed that it is not the potential alone which determines the power of the reducing effect, but also the length of time which the system can maintain the potential is vitally important, as has just been demonstrated. Before leaving this data, it is worth commenting on the fact that hydrosulfite appears to be very attractive since such high negative potentials are created. The decay rates of hydrosulfite system, however, are some 30 times faster than for sulfoxylate systems and hence hydrosulfite is only of interest for the less orthodox pad-steam or flash-age processes of printing.

The implications of the second dominant factor, namely reduction rates, will now be discussed.

RATES OF REDUCTION

From the first series of rate of reduction measurements made by Marshall & Peters (5), they were able to show that those dyes with slow rates coincided with the poor printing dyes. These rates had been measured in dilute solution in a caustic/hydrosulfite system at 40° and 60° C. It was envisaged at this stage that the time necessary to reduce the dye must be an appreciable fraction of the total steaming time in the printing process, and furthermore, it was thought that reduction in a print paste under steaming conditions must be a slower process than that obtaining in a relatively dilute aqueous dyeing system. This last assumption proved to be erroneous. By employing a specially devised apparatus (6), these workers, together with parallel work on a more technological plane by Michie and Thornton (7), uncovered the type of data shown in Table III.

It can be seen at once that, in many cases, appreciably higher rates exist in the print paste than under dyebath conditions for a given dye. In order to obtain a more practical picture, it can safely be assumed that three times the time shown for time of 50% reduction (Table III) can be taken as the time needed for full reduction. Approximately one-half of the total dyes examined have estimated print paste reduction times of 3 minutes or more and this is a considerable proportion of the steaming time commonly employed in orthodox printing practice which varies from 3-12 minutes. The rate at which the dye *fixes* must, therefore, depend on its rate of reduction and those dyes with slow rates of reduction will require longer steaming times for maximum values to be

TABLE III
RATES OF REDUCTION OF VAT DYES IN PRINT PASTES(6)

No.	Dye	Dye concn in print paste (%)	Time for 50% of max reduction: In print paste (sec)	Time for 50% of max reduction: In NaOH-$Na_2S_2O_4$ (sec)	Time to reach 80% of max fixation (sec)
1	Caledon Printing Yellow GNS (*CI* 1118)	1	5	5	270
2	Caledon Printing Red BNS (*CI* 1162)	1	8	5	220
3	Durindone Printing Blue 4BCS (*CI* 1184)	1	10	—	—
4	Caledon Navy Blue 2RS Pst Fine (*CI* 1100)	3	12	31	—
5	Caledon Printing Orange 6RS (Pr 116)	1	20	—	330
6	Caledon Prtg. Jade Green XBNS (*CI* 1101)	2	25	43	236
7	Durindone Printing Brown GS (Pr 121)	1	30	780	450
8	Caledon Printing Orange GS (*CI* 1096)	2	34	36	—
9	Caledon Yellow 4GS Paste Fine	3	35	27	—
10	Durindone Printing Red BS (*CI* 1207)	1	36	113	—
11	Caledon Printing Yellow 5GS (Pr 9)	3.5	45	—	900
12	Durindone Printing Red 3BS (*CI* 1212)	1	50	—	660
13	Caledon Brill Purple 4R 150 Pst Fine (*CI* 1104)	2	60	—	440
14	Caledon Pink RL 200 Paste Fine	4.5	60	181	—
15	Caledon Brill Violet RS Pst Fine (*CI* 1134)	6	65*	33	510
16	Caledon Printing Red 3B 200 (Pr 296)	3	75	291	450
17	Durindone Printing Scarlet 3BS (*CI* 1212)	1	80	—	—
18	Durindone Printing Pink FF 125 (Pr 109)	2	88	2880	690
19	Caledon Brown RS Paste Fine (*CI* 1151)	3	90	27	400
20	Durindone Printing Scarlet YS (*CI* 1228)	1	100	—	660
21	Durindone Printing Orange R 150 (*CI* 1217)	2	110	3000	—
22	Caledon Red 5GS Paste Fine	1.5	110*	503	—
23	Caledon Red X5B Paste Fine	3	280	390	—

*These print pastes appeared to be incompletely reduced even after max reduction had been achieved

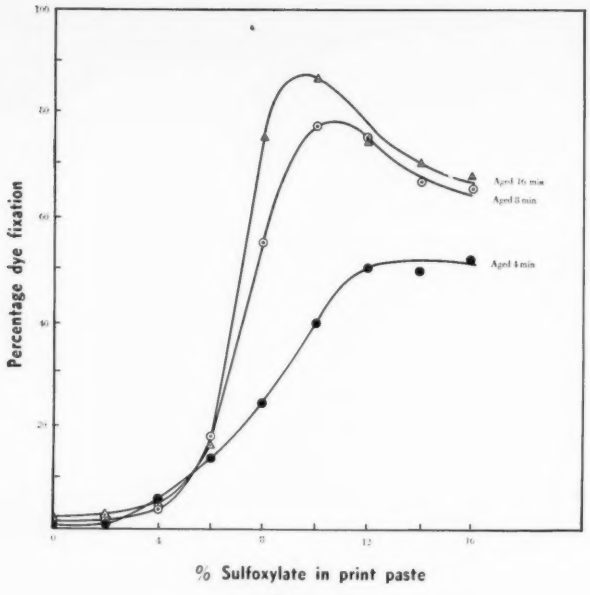

Figure 5
15% Caledon Brown RS Paste Fine (C.I. 1151)
Leuco potential = −923 mv
$T_{0.5}$ = 90 sec

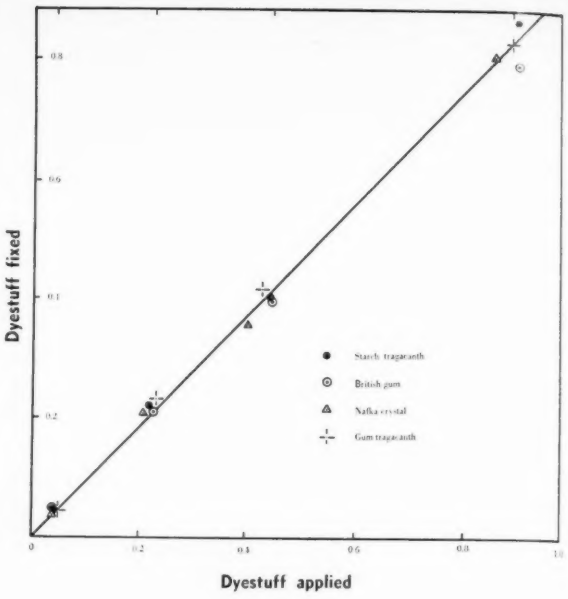

Figure 6
Caledon Ptg Jade Green XBNS (C.I. 1101) in various thickeners

realized. There is also a further possible complication of over-reduction which will be mentioned later. It is known too that even when the dye is sufficiently reduced, additional time is necessary for its effective transfer from print paste to cellulose.

SULFOXYLATE CONCENTRATION IN THE PRINT PASTE

Using a print gum formula based on British gum, 5% glycerol and 13.5% potash, Thornton & Michie (7) have produced a series of valuable curves showing the relationships between dyestuff fixed, aging times and sulfoxylate concentration. They bring together a very vivid picture of the parts played by leuco potential and rates of reduction, and illustrate the importance of working above a sulfoxylate threshold value.

Figure 3 shows the behavior of a typically good printing color, namely Flavanthrone. The dye has a low electronegative potential and a rapid rate of reduction. It represents a class of dye which can be relied upon to give reproducible results under a wide range of conditions by either roller or screen application. It is so insensitive to sulfoxylate concentration that the reducing power of alkaline British gum alone is sufficient to give good fixation.

Figure 4 shows the behavior of Thioindigoid Brown G, which belongs to the category of dyes requiring more than a specific "threshold" concentration of sulfoxylate in order to yield satisfactory fixation. Here manifestations of sulfoxylate sensitivity are apparent with short steaming times and the higher leuco potential of −817 mv is the governing factor. It is apparent from this figure that long steaming times, with a minimum sulfoxylate concentration of about 8%, is necessary for good fixation. With dyes of this type it is inadvisable to delay aging of the prints so as to avoid decomposition of sulfoxylate by air oxidation.

Figure 5 shows the behavior of Anthraquinone Vat Brown AR, which has a very high leuco potential and a low rate of reduction under printing conditions. The high potential shows itself in extreme sulfoxylate sensitivity. Its very slow rate of reduction seriously affects fixation and restricts yield to 50% of what is possible under optimum conditions. In this particular case, too, the effects of over-reduction are indicated by a fall in yield above 8% sulfoxylate and long steaming times.

It is obvious that unless printing conditions can be stabilized to peak fixation, gross variations will result from this dyestuff in a potash/sulfoxylate printing system. The limits are too fine for general adoption of this dye in the printing trade.

THICKENING AGENT EFFECTS

In order to study the effects of thickening agents on tinctorial yield, Thornton & Michie (7) studied Vat Jade Green and Vat Brown AR, representing good and poor printing properties respectively. These were applied under identical conditions in four different thickeners, with constant alkali/sulfoxylate content. No attempt was made to obtain pastes of equal viscosity but this was reconciled by the fact that very nearly equal amounts of print pastes were in fact deposited on the cloth. The gums used were starch/tragacanth, British gum, Nafka crystal gum and tragacanth. The prints showed marked differences in strength when assessed visually but when measured by spectrophotometric readings of the extracted dye, almost identical color contents were shown, regardless of gum and depth of shade (see Figure 6).

HYGROSCOPIC AGENTS

Glycerol and closely related compounds perform the dual role of humidity control agents which counteract the effect of superheat in steamers and simultaneously act as excellent dispersing or solubilizing agents for alkaline vat leuco compounds. Thornton & Michie's work (7) showed that the effect of added glycerol up to 5% of the print paste was most marked with short steaming times. The average percentage increase in fixation after 4 minutes steaming time was a little over 20% for the five dyes of widely different properties studied. As the time of

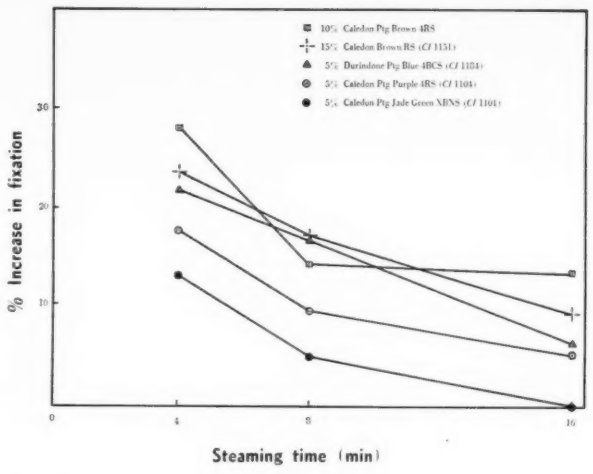

Figure 7

Effect of Addition of 5% glycerol to print paste

steaming was extended, the advantages gained by glycerol addition decreased so that after 16 minutes aging, the average increase in fixation was less than 7% (Figure 7).

Printers and chemists will be bound to agree that what has been said in this paper is sketchy and incomplete. Such studies need considerable amplification and the need for extended investigation is obvious. An attempt has been made to create some liaison between the researches of the physical chemist and the practical knowledge of the technologist. If there has been any measure of success in this aim, then the author is happy that a better technology is beginning to thrive.

Not 'til the machine is silent
And the rollers cease to fly
Will God unfold the canvas
And explain the reason why
Dark problems are as needful
For the printer's skillful hand
As the lines of gold and silver
In the pattern He has planned.

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AATCC MEMBERSHIP

FOLLOWING is an enumeration of membership according to classes and Sections, on May first, 1956, with totals of the corresponding date in each of the ten years next preceding.

SECTION	Sr	Jr	Assoc	Stu	Total 1956	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
Northern New England	416	13	64	2	495	515	549	575	576	571	567	545	550	556	528
Western New England	158	2	16	—	176	173	173	170	158	154	144	142	97		
Rhode Island	562	18	69	—	649	652	657	667	680	674	589	556	511	501	471
New York	1201	52	205	2	1460	1476	1461	1468	1468	1361	1335	1282	1285	1262	1167
Hudson-Mohawk	149	4	20	1	174	173	205	184	190	181	163	117			
Niagara Frontier	71	4	11	—	86	69									
Philadelphia	753	20	123	5	901	913	988	988	1042	1009	971	930	871	833	740
Washington	96	8	14	1	119	122	125	118							
Piedmont	814	19	118	1	952	913	874	809	778	728	669	587	511	492	434
South Central	137	6	23	—	166	162	155	148	156	144	140	128	111	102	100
Southeastern	272	14	65	—	351	314	299	273	243	229	237	224	209	198	166
Mid-West	326	11	64	4	405	413	420	417	385	353	341	336	337	326	287
Pacific Northwest	37	—	6	—	43	39	42	42	30	32	35				
Pacific Southwest	94	1	13	—	108	99	101	96	106	92	83	115	81		
Student Chapters				185	185	180	214	238	273	339	421	312	240	142	50
Unclassified	399	30	132	10	571	566	581	520	488	412	369	340	286	286	237
	5485	202	943	211	6841	6779	6844	6713	6573	6279	6064	5614	5089	4698	4180
Corporate					339	292	292	310	269	282	295	300	300	299	302
TOTALS					7180	7071	7136	7023	6842	6561	6359	5914	5389	4997	4482

Piedmont Section———

THE DYEING AND RELATED PROCESSING OF NYLENKA*

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INTRODUCTORY

WHILE research workers in this country were exploring the nature and means of polymerization which led to the discovery and manufacture of nylon, similar work was in progress in Europe. Since the resulting findings represented a large amount of effort and a very substantial financial expenditure on the part of sponsoring firms, it is natural that the important discoveries, key reactions and techniques involved were kept secret by each of them as nearly as possible until the fullest coverage by patents had been accomplished. An American concern first covered the nylon patent field so thoroughly, embracing key reactions and manufacturing methods applicable to nylon 6, as well as nylon 66, that a broad monopoly was created necessitating licensing agreements before products of this type, including nylon 6, could be manufactured or sold by other concerns in the United States. The net result of this is that, although nylon 6 is primarily a European development of a different chemical compound having some properties that vary somewhat from those of nylon 66, many years passed before a satisfactory licensing arrangement was reached permitting the offering of nylon 6 in this country by other than the holder of the original pertinent United States patents. Hence nylon 6, or Nylenka, as we of the American Enka Corporation term the product manufactured by our company, has been commercially produced and sold in this country only during recent years. The above information is offered to dispel any illusion that Nylenka is a hastily "dreamed up," or "just as good as" substitute. We believe that it has a definite place, especially in the textile field.

Although it is my impression that nylon 6 as manufactured by the various concerns does not greatly differ in chemical characteristics and properties, my remarks from this point will be confined to Nylenka which is nylon 6 as manufactured by the American Enka Corporation.

Stribling

NOTE: The statements contained herein are based upon the personal experience and opinions of the speaker and his associates, and, while given in good faith, they are not offered as statements of policy or warranties on the part of the American Enka Corporation. Successful processing of Nylenka is not limited to the illustrative procedures described in this paper.

MANUFACTURE

Epsilon caprolactam is the monomer from which Nylenka is manufactured. It may be synthesized by several different processes, most of which employ phenol as a starting material (see Figure 1).

The E-caprolactam, having a very high degree of purity, is mixed with appropriate catalytic agents and regulators and heated to 158 to 176°F followed by filtering. The resulting water-white solution may be stored for a period of time. This material is then passed through a polymerization column at 500 to 518°F with the result that up to about 200 lactam molecules unite to form a long chain molecule, which is the polyamide of amino caproic acid. This produces a more viscous, sticky mass suitable for the direct formation of filaments through jets. The process is a continuous one employing comparatively simple apparatus, and with proper control, yields a very uniform product from a chemical standpoint.

The filaments for tow or staple emerge from the jet as a liquid at about 482° F, and solidify on contact with air; they can be pulled or wound at a high speed of 18.6 to 37.3 miles per hour. The tow is drawn, crimped, and washed to remove unreacted chemicals, treated with finish, cut to the desired length for staple, dried, and baled.

The manufacture of continuous filament Nylenka differs from the above in that, after polymerization, small rodlike formations called spaghetti are extruded, which are cut into small chips, thoroughly washed in water to remove water soluble chemicals and dried. These chips are then melted on a grid and spun to form continuous filament thread which is wound and cold drawn to about 3 or 4 times the original length. Finish is added to lubricate the yarn, which is placed on supply packages for shipment. This brief schematic outline of the Nylenka manufacturing process should serve to convey some conception of the fiber with which we are concerned.

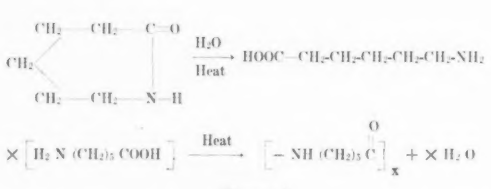


Figure 1
Schematic reactions of converting E-caprolactam into Nylenka

* Presented at the Annual Meeting of the Piedmont Section on October 29, 1955 at the William Barringer Hotel, Charlotte, NC.

$$HOOC-(CH_2)_5-NH\left[CO-(CH_2)_5-NH\right]_{\times}-CO-(CH_2)_5NH_2$$

Polyamide of aminocaproic acid $\times$ = up to 200

Characteristic repeating group

$$\left[-N-(CH_2)_5-C\right]_n$$

Figure 2
Chemical formula of Nylenka

CHARACTERISTICS AND SOME PROPERTIES

Figure 2 shows the chemical formula for Nylenka. Approximate physical properties are shown in Table I.

The softening and melting points given in Table I may vary somewhat depending upon conditions, including time of exposure and the nature of the heat. Use of somewhat higher temperatures than those stated has been found possible during rapid passes while lower softening and melting temperatures prevail in steam. It is an important fact to be remembered in some types of processing that Nylenka melts at about 63° F lower temperature than nylon 66.

Nylenka is not affected by the alkalies at concentrations usually employed in textile processing and is, to a certain degree, not affected by acid, although formic acid, hot concentrated acetic acid and concentrated mineral acids dissolve it. Most dilute concentrations of acids damage Nylenka only after a considerable period of time. Under some conditions Nylenka may be dissolved by phenol and chlorinated alcohol with heat. Some blends of solvents, such as alcohol with chlorine hydrocarbons, cause Nylenka to swell, although the individual solvents produce no such effect.

Many different types of dyes will color Nylenka. The types most frequently employed are acetate, acid, chrome and to some extent vats and naphtols. Some substantive or direct dyes also color or stain Nylenka. Sulfur and basic types are not so suitable. It is important to note that, in the case of some dyes, Nylenka absorbs up to nearly twice as much color, and the rate of absorption may be up to six times as rapid as for nylon 66. This greater dye affinity can result in a reduction of dyestuff costs for some colors, especially dark shades. The greater dye affinity of Nylenka is also being used to advantage in obtaining designs and varicolored effects when used in conjunction with nylon 66 in socks, knit underwear, and woven fabrics.

PROCESSING BLENDS OF NYLENKA WITH VISCOSE STAPLE

Gabardines and suitings are among the more popular fabric types in which staple blends of Nylenka and viscose are employed. A brief outline of the manufacture and processing of those fabrics follows.

INITIAL PROCESSING———Usually up to 20% of 3-denier, 1½-inch Nylenka staple is blended with viscose staple, which may often be 1½-denier, 1 9/16-inch, 3-denier, 1 9/16-inch or 3-denier, 2-inch, employing automatic blending equipment. If desired, up to 35% of 3-denier, 1½-inch acetate may be included. The blend is often sprayed with tint solution, to facilitate identification after drying. Later processing is aided if the dry fiber can be permitted to condition overnight or longer, but production requirements will not always permit this. The usual procedure is to put the blend through a picker having two Kirschner beaters. The lap is then carded. Some mills consider it advantageous to use metallic or self-stripping card clothing. After being drawn, slubbed and spun to 15 to 20 singles the warp yarn is slashed. A starch ether combined with softening oil and a little wax is often used. With yarn manufacture and slashing properly accomplished, weaving presents few special problems and the cloth is ready for wet processing.

Before dyeing it is well to ascertain the kind and amount of the different fiber types contained if this is not already definitely known. The microscopical, chemical and colormetric techniques for identifying most fibers are so well standardized and understood that a discussion of them will be omitted at this time. However, because Nylenka has a generally higher dye rate than nylon 66 a few quick identification methods might be pointed out. These fibers may be distinguished from each other by the fact that Nylenka dissolves within 15 seconds in 50% formic acid at 80°C (176°F) while nylon 66 requires longer than 3 minutes to dissolve under these conditions. Of the identification stains that we have tested, three are of special value when the concentration of a given fiber renders colormetric methods practical. By treating fabric or skeins for 3 minutes at the boil in solutions containing 1% on volume of the respective stain, the following color effects are produced:

	Nylenka	Nylon 66
Identification Stain (Interchemical Corp)	Dark olive	Yellowish olive
TSI Identification Stain (Testfabrics, Inc)	Dark orange to red	Light orange
Identification Stain No. 4 (Du Pont)	Dark maroon	Red

Several other fibers also develop identifying colors when so treated with these stains. A blank of known yarn or fiber types should be included in such colormetric tests to provide a basis for judgment. By knowing when Nylenka is present in a fabric, the dye formula may be adjusted to compensate for the greater affinity of Nylenka for most dyes than is the case with nylon 66.

WET-PROCESSING PROCEDURE———A typical wet-processing procedure would include treatment on a boil-off machine at the boil with a solution containing a good synthetic scouring agent or detergent, soda ash in small amount and an appropriate sequestering agent, followed by a hot rinse. To remove warp size from the cloth, one should impregnate with amylolytic or proteolytic enzymes in warm solution, according to the nature of the size contained, and permit the goods to stand for several hours or preferably over night before dyeing.

Unless the dye formula to be employed has been specifically developed for use on goods containing Nylenka, a trial laboratory dyeing should be made prior to the commercial dyeing. Some economy in dye cost can be expected. If substantive or direct dyes

TABLE I
APPROXIMATE PHYSICAL PROPERTIES OF NYLENKA

		Textile Continuous	High Tenacity Continuous
Conditioned Strength (g/den)	Bright:	5.0–5.8	7.5–8.3
	Semidull:	4.5–5.3	
Wet Strength (g/den)	Bright:	4.5–5.2	5.4–7.1
	Semidull:	4.1–4.8	
Conditioned Elongation (%)	Bright:	23.0–29.0	16.0–19.0
	Semidull:	30.2–42.5	
Wet Elongation (%)	Semidull:	27.0–34.0	15.1–18.3
Swelling—H_2O (%)		11	
Moisture regain at 65°F, 70% rh		4.5–5.0	
Softening temperature (dry)		356–374°F	
Melting point (dry)		401–419°F	

are employed for the viscose component, as is commonly done, dyes should be selected that have little or no affinity for Nylenka; or if such selection is objectionable, agents that retard the absorption of direct dyes by Nylenka should be included in the dyebath. Among the more effective retarding agents are soda ash, 0.1%; Erionol NW, 0.25-0.50%, Nyotan M, 0.25-0.50%; and Resolin B up to 1.0% (all percentages on weight of goods). Such agents preferably should be added to the dyebath, with cloth circulating, a little while before the direct dyes are added. Obviously soda ash should be used with caution if acetate fiber is present so as to avoid saponifying the acetate. Acetate dyes are often employed for the Nylenka component, and offer an advantage in also coloring any acetate fiber that may be present in the blend either purposely or accidentally (as mill fly). The use of neutral acid dyes for the Nylenka component will, of course, result in somewhat better fastness, especially to washing and staining of other fibers.

Gabardines and suitings made of these blends are usually dyed on stainless-steel becks. The cloth pieces are sewn on the machine in a tepid bath containing a small amount of mild synthetic detergent and wetting agent and a little mild alkali, such as a phosphate compound. After the cloth is briefly circulated in this bath, the dissolved retarding agent is added (if needed or desired) to retard acceptance of direct dyes by Nylenka, and the dissolved dyestuff is added soon after. The temperature is raised to 200°F in 45 to 60 minutes and dyeing continued for 10 to 15 minutes after which common salt is added in several portions at intervals of about 10 minutes. The first sample is taken 10 to 15 minutes after the last portion of salt is added. Any necessary additions of dyestuff are made and dyeing continued until the desired color is matched, which will require from 3 to 5 hours. If acetate fiber is a component of the blend, a maximum temperature of 190°F is preferred.

After completion of dyeing, the bath is dropped and the cloth rinsed thoroughly for 45 to 75 minutes in a cold overflowing bath. A mild salt rinse is then given after which the cloth is taken off the machine. Opening to full width, vacuum extraction, and drying follow.

Finishing consists of the usual treatment on a resin-finishing range followed by decatizing and perhaps calendering. Temperatures employed on the resin finishing range should rarely exceed 325°F.

Tests indicate that, if fabrics containing nylon 6 and nylon 66 are dyed and finished with similar dyes and chemicals under generally similar conditions, the fabric containing Nylenka will possess as good or better fastness than the fabric containing nylon 66.

PROCESSING OF NYLENKA-CONTAINING CARPETS——Tufted or woven carpets containing Nylenka staple in the pile either alone or blended with viscose staple seem worthy of mention.

Under some circumstances Nylenka staple is dyed separately in raw-stock form, usually with acetate dyes, although neutral dyeing acid dyes or other types are sometimes used. Likewise the viscose staple is dyed as raw stock using fast-to-light direct or vat dyes. It is important that the dyed fiber receive an effective finishing treatment either in the last wet-treating bath or by spraying afterwards. However applied, this finish should include ingredients that lubricate and impart antistatic properties, or serious difficulty may be encountered in carding and drawing because the finish which we add at Enka is partially or largely removed by the wet treatments of dyeing. Blending of the dyed Nylenka and viscose staple in the desired proportions then follows with conditioning and the yarn manufacturing operations proceeding as usual. These principles of processing may also be applied to Nylenka-wool blends. When tufted carpets are to be manufactured from yarn of stock-dyed staple, the backing fabric may be piece dyed with vat colors before the tufting operation, especially if the carpet is to be of high quality, containing a high percentage of Nylenka in the tufts.

Fifteen - denier, 3 - inch Nylenka alone or blended with 8- or 15-denier, 3-inch viscose staple and spun to 2/2,/4/3, etc, is preferred by some manufacturers for the tufts or pile of tufted and woven carpets.

Large pieces of wide carpet fabric in the greige are usually dyed on a beck at open width. Considerable care is necessary to obtain a uniform color throughout the width of the goods. However, this problem is no more difficult in carpet material containing Nylenka than in that containing other fibers, and uniformity of color from side to side is achieved by following the same principles of circulation and addition of chemicals, dye, salt, etc, that are effective on broad carpets in general. Small carpets are often dyed in large rotating drum- or cylinder-type machines, such as are commonly employed in laundries and hosiery-dyeing plants.

In carpet dyeing, acetate dyes are probably more commonly employed for the Nylenka component, and fast-to-light direct dyes for the viscose fiber and cotton backing material. As with suitings, a retarding agent may, under certain circumstances, be advisable so as to retard some direct dyes from coloring Nylenka more than desired. Neutral-dyeing acid dyes may be used for the Nylenka fibers instead of acetate dyes.

Since the dyeing procedure for carpets does not generally differ particularly from that normally employed for other fabrics, a description will not be included in this paper. It is noted, however, that the dyeing operation should be preceded, by a suitable desizing treatment if the backing fabric contains objectionable sizing material. A scouring treatment should be given to remove any oil or other foreign matter present on the pile that might interfere with uniform acceptance of dye.

After dyeing, a treatment in antistatic agent should be given if the nature of the fabric might otherwise produce static electricity when persons later walk upon the carpet.

PROCESSING OF NYLENKA FULL-FASHIONED HOSIERY

Our commercially offered line of fine-denier, continuous-filament Nylenka is not yet complete, but it is expected to be largely so during the next few months. However, this situation has limited our experience to the coarser deniers which are employed in service-weight hosiery. So far, little difficulty has manifested itself in the processing of such goods. Twisting of the component yarns to the desired turns per inch and knitting is accomplished with little deviation from the usual methods employed by most mills on goods of this general type. Knitting oils should be used that will not be fixed on the fabric by presteaming or presetting, otherwise a possibility exists that difficulty may be encountered with unevenly dyed goods and less softness in feel than is usually desired.

The best practice in presteaming varies somewhat between different mills, probably because of differences in equipment (local conditions) and in construction of the hosiery concerned. Unless some experience has been gained on Nylenka hosiery, it is well to make some small-scale experiments to determine the shrinkage obtained in steaming and/or setting treatments and in wet processing as a whole, so that any slight adjust-

ments needed in the construction of the hose may be accomplished to permit production of merchandise having the desired characteristics.

Many manufacturers find it preferable to presteam the goods from the knitting machine, before seaming and looping, using a temperature in the steaming chamber ranging between 150 to 220°F for 20 to 45 minutes. (For example, 205°F dry bulb, 185 to 195°F wet bulb).

After the looping and seaming operations, the goods are placed in cotton bags of fine texture (much like sugar sacks) for dyeing.

Opinion varies between different dyers as to the relative merits of the one- and two-bath systems of dyeing. The two-bath system probably offers some advantage from a quality standpoint while the one-bath system is lower in cost. Nylenka hosiery can be processed successfully either way but the one-bath system is usually satisfactory unless the goods contain too much oil and foreign matter that is difficult to remove.

Under the one-bath system the goods may be entered into a rotating-drum type of machine, the machine filled with cold water and sulfonated synthetic detergent, low titer soap (if soft water is used) and leveling agent added totaling about 1 to 5% on weight of goods. With the temperature raised to lukewarm, the goods are circulated 10-15 minutes and the required dissolved acetate dyes are added. After 10 to 20 minutes lukewarm, the temperature is raised to 180°F in steps, stopping 5 to 10 minutes at 120 and 150°F. Dyeing proceeds for 30 to 45 minutes more (or until color is matched) at 180°F after which the bath is overflowed with cold water and the goods rinsed. A finishing treatment in a fresh bath with resin and softener completes wet processing.

The bagged goods are centrifuged, then removed from bags and boarded or post set for 1.5 to 3.5 minutes at 230 to 240°F in steam.

It should again be noted that, before using formulas developed for goods made of nylon 66, they should be checked in the laboratory on Nylenka goods and appropriate adjustments made in the quantities of dyes necessary for the desired colors. In such instances it is often necessary to reduce the amounts of dyes with the extent of the reduction depending upon the characteristics of the individual dyes.

If the condition of the goods or other considerations make the two-bath method preferable, the separate preliminary scouring bath should include a mild alkali in addition to synthetic detergent and solvent, and it should be given at an elevated temperature up to 190°F.

PROCESSING OF SOCKS CONTAINING STRETCH NYLENKA YARNS

Nylenka continuous-filament yarn is well adapted to the manufacture of stretch yarn for men's socks both by the Helanca and Fluflon process. Since all of you who are engaged in the manuufacture of such yarns are no doubt fully familiar with the principles, techniques and equipment employed in these processing methods, and since this has been rather well covered in available literature, a detailed discussion does not seem appropriate at this time. However, it should be mentioned that, for 70/32 Nylenka processed by the Helanca method, twist setting may be done for 30 to 60 minutes (depending on package size) in steam at 240 to 250°F and for the Fluflon method 330 to 340°F during a quick pass for a fraction of a second. Yarns of larger filament diameter require higher temperature.

For some of the more popular sock styles, the yarn for knitting is prepared by twisting together an end each of S- and Z-twist stretch yarn of 70 or 100 denier and applying 2 to 4% of suitable coning oil during the coning operation.

The sock may be of plain, ribbed or fancy design construction with contrasting clocks of dyed acetate often present as a decorative feature. Knitting is usually accomplished with only minor deviations from normal practice on such nylon yarns and constructions.

After looping and greige inspection, the socks are preboarded for 30 to 60 seconds or longer at 190 to 210°F to stabilize the shape and to some extent the relationship of component threads to each other at intersections.

Assuming that the socks are plain or ribbed with contrasting dyed resist clocks and some cotton in elastic tops, direct dyes would be used for the cotton and acetate dyes for Nylenka in light colors. For dark or medium colors acid dyes are frequently employed on the Nylenka component.

A typical dyeing procedure for a medium color on Nylenka stretch yarn socks follows:

The preboarded socks in loose condition are entered into a cold bath in the dyeing machine containing a penetrant or synthetic dyeing assistant, the required acid dyes for Nylenka and direct dyes for cotton. The bath is heated to 185 to 190°F in 15 to 25 minutes with the goods circulating, and dyeing is continued at this temperature for up to 30 minutes. Common salt as necessary is added. After 15 minutes, up to 10% of acetic acid (50% concentration) or 1 to 4% formaldehyde (80% concentration) may be added in several portions at intervals and dyeing continued at 185 to 190°F for 30 minutes or until the desired color is obtained. A thorough cold rinse in a fresh bath is followed by washing for a few minutes at 120 to 130°F in a fresh bath containing a small amount of neutral soap to remove excess dyes. A warm rinse, centrifuging and boarding at 160 to 180°F complete the operation.

SUMMARY

In the foregoing discussion we have endeavored to show that the processing of goods containing Nylenka does not offer particular difficulty and that, generally speaking, no radical changes are necessary from practices generally accepted for corresponding goods containing nylon 66. However, some minor changes may be necessary because of the lower softening and melting temperature of Nylenka and the fact that a greater affinity is present for many dyes.

Specific attention is invited to the following points:

1) Nylenka is a different chemical compound from nylon 66, but the processing methods for the two are generally similar in principle in most textile dyeing and finishing operations. Many, but not all, properties of the two are similar.

2) The temperature at which Nylenka softens is somewhat lower, a fact that must be considered in the manufacture of stretch yarns and other treatments involving high temperature.

3) Nylenka is considered to be a little softer and to have slightly more affinity for moisture.

4) Acetate, acid, and chrome dyes are most suitable while vat and naphthol dyes are of some interest. Some substantive or direct dyes also color Nylenka.

5) In the case of many dyes, Nylenka is colored to greater depth and more quickly than is corresponding nylon 66. Accordingly, dye formulas must be developed for Nylenka or submitted to laboratory trials before use on commercial lots of goods.

6) Nylenka is manufactured by a continuous process rather than in batches and should therefore be of very uniform physical and chemical characteristics.

Activities of the Local Sections

Jack Fancourt (left), president, W F Fancourt Co, presents to Mort Schiff, Thermco Products, the Walter F Fancourt, Jr and Walter F Fancourt, 3rd Memorial Golf Trophy for low net. Jack Adams, golf chairman, looks on.

Thomas H Hart (left), Philadelphia Section chairman, accepts the Trophy from Mr Fancourt as A E Raimo, outing chairman, looks on.

Jack Adams (left) presents the Philadelphia Section Trophy for low gross to R C Brown of E I du Pont de Nemours & Co, Inc.

Philadelphia

THE Philadelphia Section held its annual Outing Friday, May 25, 1956 at the Huntingdon Valley Country Club, with 425 members and guests in attendance.

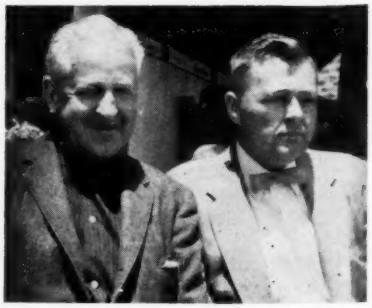
R C Brown of DuPont added a second leg to the Philadelphia Section's golf trophy for the low gross score of the day. John Fancourt of the W F Fancourt Company presented to the Section the Walter F Fancourt, Jr and Walter F Fancourt, III, Memorial Golf Trophy for the low net score. Mort Schiff of Thermco Products claimed the Fancourt trophy with his low net score.

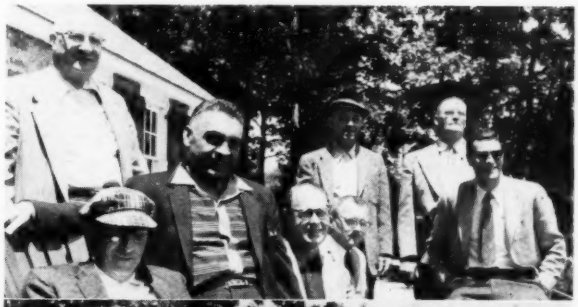
J M Chuck, Chas J Haas Co, took first prize in darts; Nevin Greenawalt, Wolfe Dye & Bleach, carded first in pinochle; and Al Stutzke and Jim Dougherty, Globe Dye Works, took top honors in quoits.

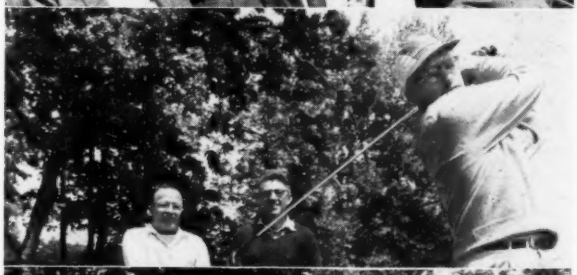
Golf was enjoyed by 200 of those in attendance. Dinner was followed by the awarding of door prizes and a floor show.

The next meeting of the Section will be at the Abraham Lincoln Hotel, Reading, Pa, on September 28.

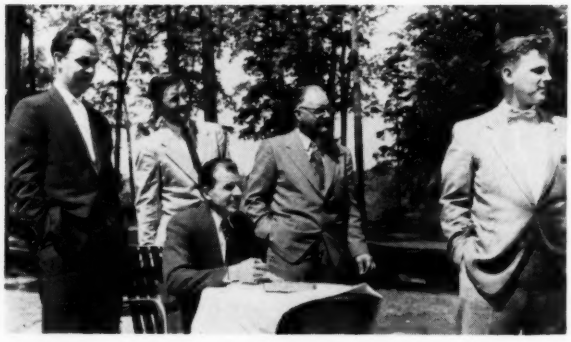
Additional Outing Photos on Pages P457-8







PHILADELPHIA SECTION OUTING



Fluorescence———

(concluded from page 440)

ALIZARINE CYANINE RR (*CI* 1050)

Colour Index, Water —Insoluble.

Colour Index, Glacial Acetic Acid —Yellowish-red solution with a green fluorescence.

HEM, Glacial Acetic Acid —*Daylight*—yellowish-red solution with a tint of greenish fluorescence.

HEM, Glacial Acetic Acid —*Ultraviolet*—dull, scarlet fluorescence.

Colour Index, H_2SO_4 Conc —Blue solution with a red fluorescence.

HEM, H_2SO_4 Conc —*Daylight*—blue solution (actually violet) with a tint of red fluorescence.

HEM, H_2SO_4 Conc —*Ultraviolet* — dull, scarlet-red fluorescence.

ANTHRACENE BLUE WR (*CI* 1062)

Colour Index, Water —Insoluble.

Colour Index, Alcohol —Red solution with a yellow fluorescence.

HEM, Alcohol —*Daylight*—hot, red solution with a yellow fluorescence.

HEM, Alcohol —*Ultraviolet* — dull, orange-red fluorescence.

Colour Index, H_2SO_4 Conc —Violet-blue solution with a brownish-red fluorescence.

HEM, H_2SO_4 Conc —*Daylight*—violet-blue solution with a brownish-red fluorescence.

HEM, H_2SO_4 Conc —*Ultraviolet* — smoky, scarlet-red fluorescence.

HEM, H_2SO_4 Diluted —*Daylight* — dull red solution without fluorescence. With further dilution, solution has a slight fluorescence.

HEM, H_2SO_4 Diluted —*Ultraviolet* — dull, brick-red fluorescence.

ANTHRACENE BLUE WRS (*CI* 1063)

Colour Index, Water —Red solution.

HEM, Water —*Daylight*—red solution without fluorescence.

HEM, Water —*Ultraviolet*—dull scarlet fluorescence.

Colour Index, Alcohol —Insoluble.

Colour Index, H_2SO_4 Conc —Bluish-red fluorescent solution, red solution on dilution.

HEM, H_2SO_4 Conc —*Daylight*—bluish-red solution with a brownish fluorescence.

HEM, H_2SO_4 Conc —*Ultraviolet* — dull, brownish-red fluorescence.

HEM, H_2SO_4 Diluted —*Daylight*—red solution with a slight fluorescence.

HEM, H_2SO_4 Diluted —*Ultraviolet* — dull, yellow-orange fluorescence.

CIBA PINK B (*CI* 1207)

Colour Index, Xylene —Red solution with a yellow fluorescence.

HEM, Xylene —*Daylight*—red solution with a yellow fluorescence.

HEM, Xylene —*Ultraviolet*—bright scarlet fluorescence.

HELINDONE PINK BN (*CI* 1211)

Colour Index, Xylene —Bluish-red solution with a yellow fluorescence.

HEM, Xylene Conc —*Daylight*—bluish-red solution with a yellowish-red fluorescence.

HEM, Xylene Conc —*Ultraviolet*—bright scarlet fluorescence.

HEM, Xylene Dilute —*Daylight*—bluish-red solution with a yellow fluorescence.

HEM, Xylene Dilute —*Ultraviolet* — bright yellowish-orange fluorescence.

Challenge to Research——

(concluded from page 444)

a much larger proportion of projects should be undertaken in industrial laboratories and research institutions supported by additional funds.

Needs and opportunities in this field for scientists and technologists reside in not only research on all aspects of the problems, as outlined here, but also in working with legislators and governmental agencies in drafting and applying sound laws and regulations, and in informing and obtaining cooperation of the public. Sound laws and regulations cannot be drafted without cooperation of scientists and technologists with the lawyers. The former must lay the foundations on which the legal structures can be erected without squandering the economic resources of the country. The public should be informed of this and of the progress being made so that it does not demand premature erection of the legal structures before technically and economically sound bases can be laid.

Opportunities to serve effectively in these capacities are enhanced by the many opportunities for attendance at meetings of scientific and technical societies, industrial associations and special conferences which have programs on these problems, and by opportunities for association with committees on the problems of water and atmospheric pollution which are connected with scientific and technical societies, industrial associations, and governmental agencies. Private citizens can even serve as members of some Pollution Control Boards. These associations provide an individual with opportunities not only to learn better what is needed in the way of research and legislation but also to work on these needs cooperatively with others.

The challenges of these problems cannot be met without the active and constructive interest, and support of employers of scientists and technologists in industry, who have wastes problems, and in institutions which have research facilities. This interest and support should recognize the need for applying the highest type of research talent available at rates of remuneration which are the same as those for the same quality of talent in other activities. Although the value of this research is not as tangible as the development of a production process the obvious fact that the wise spending of billions of dollars are at stake should be a sufficient challenge to the imagination as to its value. It might appear that an incredible amount of research is needed but, if not carried out, the cost of misdirected pollution control could be incomparably higher economically and socially. Ample and wisely directed research can serve to provide lighted guide posts along the road to pollution control which would enable us to reach our destination without wasting our resources, frequently, by going in circles in the darkness.

News of the Trade

Vat Dye Institute to Be Formed by U S Dye Mfrs

Plans to form a new trade association, to be known as the Vat Dye Institute, were made public on June 18th by a group of the country's chemical and dye manufacturers.

The new Institute will be incorporated under the laws of the State of New York. The following manufacturers have indicated their intention of becoming members: American Aniline Products, Inc; American Cyanamid Company; Arnold Hoffman & Company, Inc; Dow Chemical Company; E I du Pont de Nemours & Co, Inc; General Aniline & Film Corporation.

Also, Metro Dyestuff Corporation; National Aniline Division, Allied Chemical and Dye Corporation; Nyanza Color and Chemical Company, Inc; Otto B May, Inc; Peerless Color Company, Inc; the Pharma Chemical Corporation; and Toms River-Cincinnati Chemical Corporation.

The purposes of the Vat Dye Institute, according to its proposed charter, will be to increase and expand the consumption of vat dyes by promoting their proper end uses through advertising and educational programs; to participate in cooperative programs with all other persons concerned in developing information to promote the proper end use of vat dyes; and generally to do all things to foster good relations between the dye industry of this country and converters, manufacturers, retailers, consumers, and all other persons concerned with the use of vat dyes in textiles.

The election of officers and appointment of an executive secretary will be announced.

L22 Standards to be Revised

The American standards for rayon and acetate, known as L22, will undergo a revision according to "advances in technology and experience of the industry." These standards will be merged with the project on all textiles (L25) and the complete project will be designated "L22."

The National Retail Dry Goods Association, sponsors for both L22 and L25, made the merger proposal to the American Standards Association's Consumer Goods Standards Board, the group responsible for administration of the textile standards projects.

J Gordon Dakins, executive vice president of NRDGA, gave these reasons for the proposed merger: "Since there is much of the same organization membership on both committees, and since the L22 standards have become well known in the trade, there is overlapping of work and confusion between the two projects. We request amalgamation to simplify the procedures, insure uniformity of requirements and make possible more effective educational activities than would be the case if the work were divided."

The new scope for the combined projects covers: specifications, methods of test and performance requirements for fabrics in terms of their end-use, regardless of fiber content, for men's wear, women's wear and home furnishings; the development of suitable procedures for promoting the use of any standards developed under this project by means of labels, tags or other effective methods.

Old Slater Mill Museum Open for 2nd Season

The Old Slater Mill Museum in Pawtucket, R I opened June 15th for its second season. The Mill, which has long been recognized as a familiar historic landmark, will remain open through Labor Day.

On display are some of the early textile machines which were the basic implements of our industrial revolution. Here, too, are exhibits of early textile methods and practices, commencing with a pictorial presentation of the story of Samuel Slater and the American textile industry in its infancy.

The Museum is under the direction of a new curator, Donald Shepard, formerly director of the submarine museum and library in Groton, Connecticut.

The Museum will be open from 10 AM to 5 PM and will be closed on Mondays. Charges are 25¢ for adults and 10¢ for children—family groups are $1.00.

Sayles Finishing Signs License Agreements with Bancroft

The Sayles Finishing Plants, Inc, Saylesville, RI, have signed license agreements with the Joseph Bancroft & Sons Company.

The license agreements include the right to use the Everglaze and Everglaze Minicare trademarks, which signify that the fabric has been processed and tested according to standards prescribed and controlled by the Bancroft Company.

Interchemical Acquires Angier

Interchemical Corp last month acquired the industrial adhesives business of Angier Products, Inc. The acquisition involves the transfer of the Angier manufacturing facilities and other properties in exchange for Interchemical stock.

Angier has plants in Cambridge, Mass, and Huntington, Ind. It was founded in Cambridge in 1931 by the late Donald Angier.

Angier will operate as Angier Adhesives Division of Interchemical with its present management and staff. Henry S Bothfeld, president of Angier, will become division president of the new Interchemical unit.

CHEAPER BY THE DOZEN—Continued interest of the textile industry in laboratory equipment is shown in this recent job lot of 12 laboratory pads built by H W Butterworth & Sons Co, Bethayres, Pa. According to Edward S Pierce, vice president, "they are cheaper by the dozen". Butterworth has manufactured more than 500 of these units at significant savings in manufacuring cost.

The Butterworth Laboratory Padder has a friction let-off at the entering side and slip belt winder at the delivery side.

Cyanamid to Produce Creslan on Large Scale

Nearly a decade of research and pilot plant development by American Cyanamid Company were climaxed last month by the company's disclosure of plans for the large-scale commercial production of a new acrylic textile fiber trademarked *Creslan*.

The news that Cyanamid had definitely decided upon a major capital investment to manufacture Creslan acrylic fiber was made known by K C Towe, president. Construction of the plant will begin in December, 1956, and according to present schedule, will be in production by the second half of 1958. Limited quantities of the fiber will be made available toward the end of this year from production at Cyanamid's pilot plant in Stamford, Conn. Full-scale marketing of Creslan will start about the middle of 1958.

In making the announcement, Mr Towe also said that a site in northern Florida had been selected tentatively, but that final decision could not be made until complete details of the special problems involved in locating and building a chemical processing plant were worked out.

Mr Towe pointed out that plans for the plant were well along and that an annual production capacity of 27 million pounds, staple and tow, is envisioned with a 100 percent expansion potential embodied in the original plant design.

On the basis of extensive wear and end-use tests already completed, Mr Towe stated that some of the applications of Creslan suggested are jersey fabrics, sweaters, sportswear, blankets, fleeces and simulated fur fabrics, dresses, men's and women's suitings and overcoatings, children's wear, and certain industrial and nonwoven fabrics.

Cyanamid officials have expressed confidence that they have in Creslan a fiber of markedly superior dyeability.

Proctor Chemical Expansion

The overall expansion program of Proctor Chemical Co, Inc, Salisbury, NC, continues, with the completion of a new warehouse of approximately 15,000 square feet.

The installation of two glassed steel reactors of 500- and 1,000-gallon capacity has also been completed. Both vessels are equipped with distillation apparatus and may be operated under pressure or vacuum. These vessels augment the existing high-temperature glassed steel reactors. A new 2,000-gallon stainless-steel-jacketed vessel has also been installed.

Georg Heberlein, Jr, of the firm of Heberlein AG, Wattwil, Switzerland, recently visited the Southern Utilization Research Branch of the Agricultural Research Service, USDA, in New Orleans, La, to discuss research on cotton utilization. Pictured, left to right, are F S Perkerson, acting head of the Cotton Chemical Processing Section, SURB; C H Fisher, chief of the Branch; Dr Heberlein, and G E Goheen, assistant chief of SURB. The visitor was especially interested in the new work at the Southern Utilization Research Branch on the chemical finishing and modification of cotton, flame-and weather resistance, electron microscopy, decrystallized cotton, and infrared analysis of chemically modified cotton.

Textile Printing Exhibition at Cooper Union

The special exhibition devoted to the art of printing fabrics, which opened last Spring at the Cooper Union Museum and is slated to run through August, continues to attract numerous visitors.

The exhibition seeks to cover the field of textile printing in the areas of contemporary fabric achievements, technical methods, and historical examples. In addition, seminars, such as the recent Blue-Resist "Field Day," serve to round out the program.

More than 40 participants were on hand May 17th for the Blue-Resist "Field Day," to which many brought resist-printed textiles and other illustrated material from their own collections or from those of their respective museums.

The section of the Cooper Union Museum devoted to contemporary fabrics is illustrated by printed textiles since the end of World War II, embracing both apparel and decorative fabrics. Achievements in design of the textile industry today are highlighted.

The processes of fabric printing are illustrated in another section, among them batik, engraving and roller printing; die, block, plate, stencil and silk screen printing; discharge, direct and resist printing; and supplementary finishing processes.

The extensive historical section illustrates the vast range and diversity of printed designs from all over the World.

The Cooper Union Museum is located at Cooper Square and Seventh Street, New York, NY. Hours: 10 am to 5 pm weekdays.

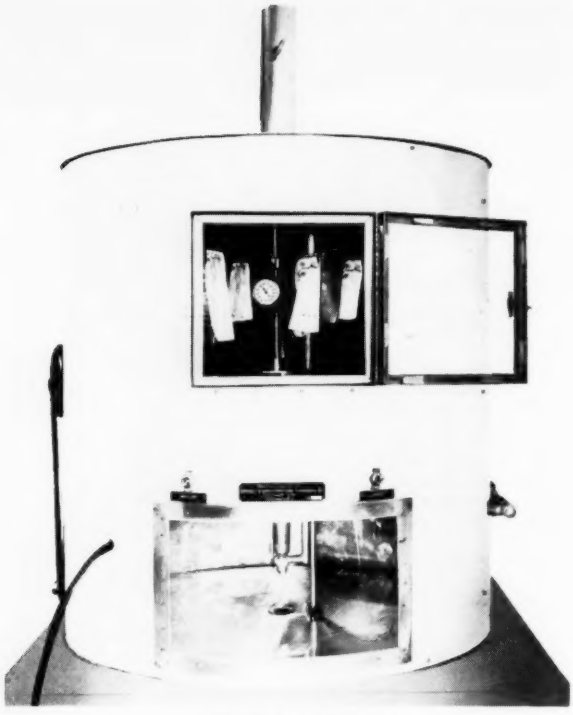
National Aniline Sales Organization Meets

On May 23-25, Allied Chemical's National Aniline Division brought together its entire sales force for a series of meetings at its dyestuffs and organic chemicals manufacturing works at Buffalo, NY.

A hundred and five men from all branch sales offices and from the head office at 40 Rector Street, New York, attended. Among those present were D G Rogers, president of National Aniline Division; H J Daigneault, vice president in charge of sales; H L Rieg, director, dyestuffs sales and branch operations; O M Morgan, director, chemical sales; W Minnis, director of research and development; and branch managers from eight of the nine branch offices throughout the United States and Canada.

The first day was given over to visiting the new multimillion dollar Research and Engineering Center at the Buffalo Plant. Throughout the day, the sales representatives sat in on group discussions and round table sessions with chemists, engineers and operating and test inspection men from the Buffalo Plant organization for a face-to-face exchange of information and ideas.

On the following day, groups of sales organization men were conducted throughout those portions of the plant in which they were particularly interested. The manufacturing and test procedures were explained by guides selected from the supervisory staff of the plant. A final meeting of the entire sales organization climaxed the third day of the conference.



Gas-Fading Chamber

U S Testing to Market Gas-Fading Chamber

The Gas-Fading Chamber, originally developed by the United States Testing Company, Hoboken, NJ, in cooperation with AATCC Committee on Atmospheric Gas Fading, for evaluation of atmospheric gas reactions on dyed textiles, is now being manufactured for direct sale to industry. The decision to market this new instrument, in addition to the test service, was made in response to the demands of manufacturers of fume-vulnerable goods who seek a convenient and practical means of product evaluation and control.

The instrument is made in two models, the drum type, which conforms to specifications of the American Society for Testing Materials (D 682-52), the American Standards Association (L-14 and L-22), and the American Association of Textile Chemists & Colorists, and the more compact "squirrel cage" model, which meets requirements of the last two. Both instruments feature a corrosion-resistant chamber, self-sealing closure and exhaust vent, which permit operation with a wide variety of gas fumes. By introducing special valve ports into the main supply line, it is possible to mix and feed controllable quantities of different gases to the chamber. In addition, the automatic rotation of samples in the chamber assists gas circulation and achieves uniform exposure conditions. Interior lighting permits observations to be recorded during progress of the test, and a dial thermometer enables testing to be accomplished at a known temperature.

With the widespread occurrence of product deterioration by atmospheric gases and the limited success in meeting it, a variety of industries are utilizing the so-called Gas-Fading Chamber for testing resistance of dyes and pigments, efficacy of inhibitor substances, and the susceptibility to gas absorption of specific materials. The United States Testing Company will forward literature on this instrument or work out special applications of the instrument with interested manufacturers.

Rambach Chemical Moves to Larger Quarters

Rambach Chemical Co, headed by Harvey W Rambach, has announced their removal to new and larger quarters at 93-03 Sutphin Boulevard, Jamaica 35, New York, as of June 15. New phone is AXtel 7-8900.

Specializing in the buying and selling of surplus chemicals, the firm serves as a market place for all types of dyestuffs, pigments, resins, solvents, pharmaceuticals, plastics and allied material.

NSP Doubles Meredosia Capacity

The production capacity of polyvinyl acetate polymers has been doubled at National Starch Products Inc new Meredosia, Illinois plant, culminating an expansion program which began early last Fall.

Polyvinyl acetate emulsions, and adhesives compounded from these resins are produced at this plant as well as National Starch's plant in Plainfield, NJ.

General Calendar

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
Gordon Research Conference—Textiles Program, July 9-13, Colby Junior College, New London, N H.

AMERICAN ASSOCIATION FOR TEXTILE TECHNOLOGY, INC
Sept 5, Oct 3, Nov 7, Dec 5 (All meetings at the Vanderbilt Hotel, New York, N Y).

AMERICAN OIL CHEMISTS SOCIETY
Spring, 1957 (Spring meeting, New Orleans); Sept 30-Oct 2, 1957 (Fall meeting, Cincinnati); Apr 21-23, 1958 (Memphis); Oct 20-22, 1958 (Chicago); Spring, 1959 (New Orleans); Fall, 1959 (Los Angeles).

AMERICAN SOCIETY FOR TESTING MATERIALS
Sept 16-22—2nd Pacific Area National Meeting and Apparatus Exhibit, Hotel Statler, Los Angeles, Calif; Oct 16-19—Fall Meeting of Committee D-13 on Textiles, Warwick Hotel, New York, N Y.

THE FIBER SOCIETY
Fall Meeting—Sept 6-7, Warwick Hotel, New York, N Y, Spring Meeting — May 1-2, 1957, The Clemson House, Clemson, S C

THE INSTRUMENT SOCIETY OF AMERICA
11th Annual Instrumentation-Automation Conference and Exhibit—Sept 17-21, New York Coliseum, New York, N Y

LOWELL TECHNOLOGICAL INSTITUTE
Sept 26-28 (Perkin Centennial observance and open house).

NATIONAL COTTON COUNCIL OF AMERICA
October 3-4 (Chemical Finishing Conference, Hotel Statler, Washington, DC); Feb 28-Mar 1 (Cotton Research Clinic, General Oglethorpe Hotel, Savannah, Ga).

PERKIN CENTENNIAL
September 10-15. Waldorf-Astoria Hotel, New York, N Y.

THE QUARTERMASTER ASSOCIATION
Annual Convention—Oct 27-28, Conrad Hilton, Hotel, Chicago, Ill.

SOUTHERN TEXTILE EXPOSITION
19th Exposition, Oct 1-5, Textile Hall, Greenville, S C.

SYNTHETIC ORGANIC CHEMICAL MANUFACTURERS ASSOCIATION OF THE UNITED STATES
Sept 11, Oct 9, Nov 7 (Palm Terrace Suite, Hotel Roosevelt, New York, N Y).

• NEW PRODUCTS AND DEVELOPMENTS •

Procion Dyes

News of an important new range of synthetic dyes has recently been announced by Imperial Chemical Industries Limited of England.

The new class of dyestuff has been given the trade name "Procion." The first three of the Procion dyes will shortly be made available to the U S textile trade through ICI's associated company, Arnold, Hoffman and Company, Inc. These three dyes are a rich golden yellow, a brilliant red and a bright blue. A wide range of shades is said to be obtainable by mixing in various proportions.

Procion dyes reportedly combine chemically with cellulosic fibers by dyeing and printing methods to give outstanding fastness and they are said to be especially suitable for modern high-speed continuous dyeing processes. The Procion dyes are expected to be of considerable interest for dyeing nylon and printing wool and silk fabrics.

Hartoset E

Hart Products Corp has announced the development of Hartoset E, a new thermosetting textile resin. Hartoset E is described as a low-polymeric resin of the modified urea type. It is claimed to be a highly efficient stabilizing resin for shrinkproofing and creaseproofing of cottons, rayons, acetates and synthetics, and to have been successfully milltested in the formulation of "minimum-care" and "drip-dry" finishes.

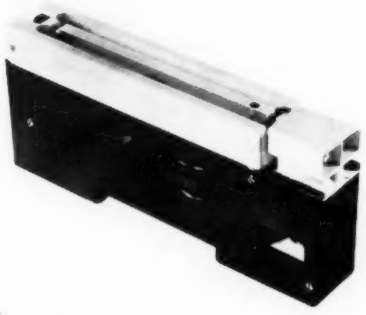
Hartoset E is said to have unlimited storage life, to be readily soluble, giving pad baths of long stability, and to have excellent compatibility with softeners, thickeners, and vinyl and silicone emulsions. When applied and cured with Hartex Catalysts RH or E4, it is said to give creaseproofing, shrinkproofing and embossing effects durable to repeated laundering.

Samples of Hartoset E and Technical Data Sheets on its applications are available from Hart Products Corp, 1440 Broadway, New York, N Y.

Virginia Smelting Producing Hydroxylammonium Sulfate

The Virginia Smelting Company began producing hydroxylammonium sulfate ——— $(NH_2OH)_2.H_2SO_4$ ——— on June 1st.

Two grades are being offered: a high purity 95% product, identified as VHS_{95}, and a technical grade identified as VHS_{60}.



MOISTER TESTER — The Psychron is a battery-operated psychrometer developed by the Friez Instrument Division of Bendix Aviation Corporation. The new instrument, designed for U S Weather Bureau and various commercial applications, is compact and self-contained. It weighs two and one-half pounds, and is 10 inches long, 4 5/16 inches high, and 1 13/16 inches wide. Both the Weather Bureau model and the commercial model feature a red, white, and charcoal gray color combination.

Color Tolerance Computer

A new electronic Color Tolerance Computer has been announced by Instrument Development Laboratories, Inc, Needham Heights, Mass. This instrument, used with a colorphotometer, computes deviations from color standard and presents the answer as a single number on a dial calibrated in NBS (National Bureau of Standards) units. The calculation reportedly can be completed within one minute. When deviation beyond the acceptable tolerance is shown, the Color Tolerance Computer will present, in NBS units, the precise color errors: light-dark, red-green, and yellow-blue. According to the manufacturer, this instrument will compute the correction necessary to obtain the required color, after which the formula can be brought within tolerance standards with a minimum of color adjustments.

Although designed for use with the IDL Color-Eye colorphotometer, the Color Tolerance Computer is equally useful with colorphotometers of other manufacturers. This instrument is based on a new arrangement of the mathematics involved in the Hunter and Adams systems of color tolerance computation. Yet it is reported to be simple to operate. Range of Color Tolerance Computer is from 0 to 20 NBS units. Accuracy is said to be ± 0.1 NBS unit or 3%, which is well within the tolerance of commercial color requirements.

Crush-Resistance Catalyst

The use of zinc nitrate as an acidic catalyst with cyclic urea or other specialized resins is finding favor in the finishing of wash-and-wear cottons and rayons. Indications are that the use of this salt results in a product having good crush-resistance, and lowered chloride retention. Better break strength may be expected as a result of the lower curing temperatures required, it is claimed.

Zinc nitrate produced by J T Baker Chemical Co, Phillipsburg, NJ, in bulk quantities has been employed in recent production runs by textile finishers, and test quantities are being made available to the industry by Baker.

New Sandoz Dyes

The release for sale of Artisil Direct Blue Green has just been announced by Sandoz Chemical Works, Inc. This dye is said to possess excellent fastness to sunlight on acetate and nylon fibers, and to show good resistance to salt water, perspiration, and crocking. It is claimed to be especially suitable for dyeing nylon fabrics which will later be heat treated, and to be useful in the production of greens and turquoise shades where both quality and economy must be considered.

Pyrazol Fast Brilliant Red RA is a new Sandoz dye which yields bright reds on cotton and cellulosic fibers. It reportedly has excellent building-up properties, thus making it of special interest to dyers of spun viscose fabrics. Pyrazol Fast Brilliant Red RA covers barré viscose and reserves acetate. Its high degree of solubility is said to recommend it for all types of closed-machine dyeing. It has good affinity for natural silk from acetic acid baths.

Lanasyn Red 2GL Pat, another new Sandoz product, is a homogeneous, metallized dyestuff which dyes wool, silk and nylon in bright yellowish red shades. Lanasyn Red 2GL Pat is said to be remarkably fast to light and to milling. Level dyeings reportedly are obtained even on tippy wool. It is suitable for Vigoureux printing.

Literature on Artisil Direct Blue Green and Pyrazol Fast Brilliant Red RA (Circular 1283), as well as inserts for the Sandoz Lanasyn Pattern Cards numbers 1220 and 1223 illustrating Lanasyn Red 2GL Pat, are available at all Sandoz offices.

USDA Combination Flame-Retardant Treatment for Cotton Fabrics

Two flame-retardant treatments for cotton fabrics have been combined into a single treatment which is said to be more efficient than either alone. Details of the process have been announced by the Southern Utilization Research Branch of the Agricultural Research Service, USDA, New Orleans, La.

One of the processes utilizes tetrakis (hydroxymethyl) phosphonium chloride (THPC) and the other is an emulsion of bromoform-triallyl-phosphate polymer (BAP). USDA chemists found that the two treatments can be applied simultaneously to the fabric from a single bath. A basic proportion of 65% THPC resin and 35% BAP emulsion, which is reported to have been found generally satisfactory, can be varied to meet special requirements.

The vertical flame test and the "match test" were used to gauge effectiveness of the treatment. For the match test, a strip of cloth ¼-inch wide and 10 inches long was suspended vertically in a draft-free area. Attempts were made to ignite it with a match or other small flame held usually for about 6 seconds. If the strip did not burn on removal of the flame it was rated "excellent." Sateen and twill, 8-oz weight, were classed "excellent" after six launderings; after 12 launderings these materials rated "good," that is, although they flickered and burned, the fire went out in the bottom 3 or 4 inches. Print cloth of 4-oz weight failed the match test with an 18% add-on, by weight, but rated "excellent" through one laundering, and "good" through six launderings with a 25% add-on.

Tear resistance varies with the type of fabric treated. That of twill is said to remain practically unaffected by the treatment, while sateen of about the same weight showed marked initial loss, but after 12 launderings tear resistance of the treated sateen is 90% of the untreated, it is reported.

The treatment was developed in cooperation with the Army Quartermaster Corps' Research and Development Command, Natick, Mass with funds supplied in part by the Office of the Quartermaster General. Since development of flame-resistant fabrics for military use was one of the objects of the investigations, most of the work was done on 8-oz cotton twill and sateen of the types used in military garments. The process is said to have many advantages, however, for application to civilian goods. It is reported that increase in weight is not great enough to be objectionable; add-ons of about 18% are required on 8- to 9-oz fabrics for a high degree of permanent flame resistance. Lighter fabrics require a higher add-on to obtain maximum flame-resistance. Appearance and hand of the treated fabric show little if any difference, and in some cases may be considered to be improved.

The method of laboratory application of the treatment to 8-oz cotton twill is described, along with the results of the THPC treatment on a number of other fabrics, in "Application of the THPC Flame-Retardant Process to Cotton Fabrics" published in the May 9, 1955 issue of *Am Dyestuff Reptr.* "Bromine-Containing Phosphonitrilates as Flame-Retardants for Cotton," "Cotton Made Flame-Resistant with Bromine-Containing Phosphonitrilates in Combination with THPC Resins" and "A Compounded Flame-Retardant for Cotton Fabrics" appeared in *Textile Research J* for February 1956. Reprints of all of these papers may be obtained without cost from the Southern Utilization Research Branch, 1100 Robt E Lee Blvd, New Orleans 19, La.

Convax

A new "after-wax" for Dacron, nylon and spuns has been developed by Bryant Chemical Corp, N Quincy 71, Mass. Their *Convax* is a high-melting-point, protective coating wax that is said to be 100% emulsifiable. It is claimed that it will not gum up at the slasher or looms or create any finishing problem. Convax is applied with an applicator that will fit most any slasher. Constant wax level is maintained with size level control to assure even application. The unit is said to be completely automatic and easily installed.

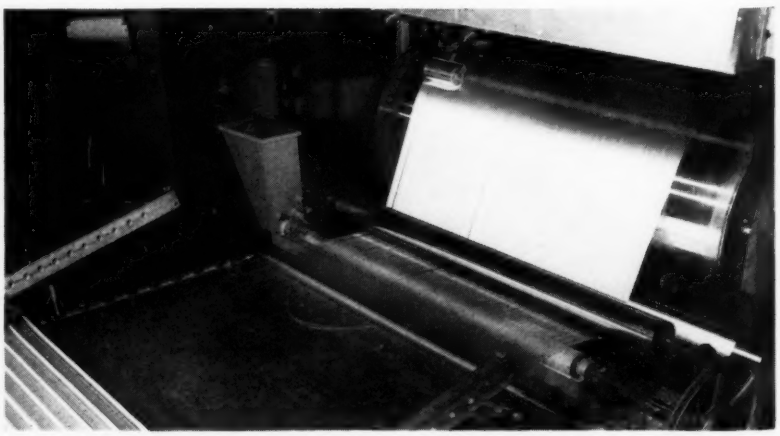
New Du Pont Dyes

Two new dyes, one developed specially for Orlon acrylic fiber, the other for the printing of rayon and cotton, were recently announced by the Du Pont Company.

Sevron Brilliant Red B is a bright, bluish-red cationic dye designed for dyeing types 42 and 39 Orlon staple. It yields brighter and bluer shades of pink and red on this fiber than can be obtained with Sevron Brilliant Red 4G. It reportedly dyes rapidly, builds up well, and has good fastness to light and wet processing. Level dyeings, particularly in light shades, are said to be obtained by the use of Du Pont Retarder LAN. Its shade is unaffected by differences in the pH of dyebaths over the pH range of 3.0 to 10, it is claimed, but applications from neutral or alkaline dyebaths cause a trace to appreciable loss in strength. It is said to be suitable for dyeing blends of Orlon and wool or Orlon and rayon as its staining of wool and rayon is negligible.

Sevron Brilliant Red B reportedly exhibits practically no affinity for nylon and has only moderate affinity for acetate and silk. It is not recommended by Du Pont for acetate and silk because of very poor fastness to light and washing on these fibers. On Acrilan acrylic fiber it is said to exhibit good affinity and build-up, fair lightfastness, and good wetfastness.

Leucosol Black G Double Paste is an anthraquinone vat dye for the printing of cotton and rayon. It is a nondrying assistant paste which is said to be of particular interest because of its outstanding lightfastness and good fastness to crocking and mark-off. Its lightfastness properties are superior to those of Sulfanthrene Black PG Double Paste and Leucosol Black N Double Paste.



Slasher Equipped with Convax Applicator

Buschman Jet/Mogenizer

Jet/Mogenizer

The improved one-HP Jet/Mogenizer, a new piece of homogenizing equipment which reportedly can fulfill the production needs usually entrusted to 3½- to 5-HP models, has been introduced by Buschman Products Inc, 369 Lexington Ave, New York 17, NY.

The following information on the unit is supplied by the manufacturer.

1) At 3600 rpm it will process approximately 100 lbs/hr of semipaste or other viscous materials having viscosities up to 30,000 cps.

2) Rotor-stator clearance is adjustable through vernier-type controls to adapt it to various types of fluids.

3) With the Jet/Mogenizer, mixing time of batch operations can be reduced as much as 80% plus the assurance that every particle of a wet/dry formulation will be completely dispersed into a truly homogenized fluid.

4) It lends itself particularly to continuous operations where uniformly dispersed formulations are a requirement.

5) Dispersions remain stable and the shelf-life of stock solution is extended over a longer period of time; quality is stepped up through increased dispersion of all ingredients; color values of dyestuffs are magnified.

6) Cooking operations for some gums and starches can be completely omitted by a single pass of the wet/dry mix through the Jet/Mogenizer.

7) Undissolved lumps are absolutely eliminated.

8) The Jet/Mogenizer will accelerate peak viscosities of sizings, gums or starches; filtering is likewise precluded.

Methyl Acetate Available in Quantity from Borden's

Methyl acetate is now available in large commercial quantities from the Polyco-Monomer Department of the Borden Company's Chemical Division, 350 Madison Ave, New York, N Y.

It is a lower-cost acetylating agent and replacement for ethyl acetate, other higher esters and acetic anhydride. Its uses include those in the manufacture of dye intermediates, leather processing, etc.

Borden's methyl acetate is described as a water-white, flammable liquid having a pleasant, ester-type odor. It is 95 percent acetate, will undergo all reactions typical of organic esters, and has relatively low toxicity, it is claimed.

The Chemical Division of the Borden Company also manufactures Methac-60 and Methac-80, low cost methyl acetate type solvents.

Tanavol

Tanatex Corporation has announced commercial availability of Tanavol, its new dye carrier, which is claimed to completely eliminate carrier-spotting of Dacron and its blends.

Tanavol is said to have all the advantages of phenolic carriers but none of their disadvantages, providing simple one-step dyeings, maximum color yields and light fastness. Another important feature is that the product lends itself to the making of dyestuff adds during prolonged processing. Tanavol reportedly forms clear colloidal solutions at application concentrations, resulting in an absence of local high concentrations that lead to spotting.

Upon request, Tanatex Corporation will supply samples or demonstrate Tanavol in the dyehouse. A technical bulletin on Tanavol containing full application data, is available from the Tanatex Corporation, Belleville Turnpike, Kearny, N J.

Cyanatex SB-100

American Cyanamid Company has gone into semicommercial production of a new textile softener which is said to have remarkable resistance to discoloration on aging.

The new softener, Cyanatex SB-100, has been run through exhaustive heating tests to prove its resistance to discoloration. It reportedly gives unusual softness and lubricity to all synthetic and natural fibers. Very low concentrations are required for maximum softness, it is claimed. It is further claimed that Cyanamid's SB-100 is very resistant to scorching, minimizes migration of such dyes as naphthols, and affords the softness necessary for sewing of tightly woven and harsh fabrics.

The new softener is a synthesized ester derivative of sulfosuccinic acid, neutral in reaction and anionic in nature. It is said to be compatible with anionic and nonionic agents, starch and salts commonly used in textile finishing, and to give less condensation in tenter frame housings and loop dryers than most other softeners on the market.

Cyanamid suggests that SB-100 can be used for off-the-loom fabrics, all knit goods, starch finishes, weighted finishes, package-dyed yarns, tufted spreads, percale sheeting and as a lubricant for yarns and as a plasticizer for polyvinyl acetate finishes, to name a few.

The new product is in paste form with density of 8.0 pounds per gallon, is readily dispersible in a temperature of 140° F, and is stable at the boil or when cooled, it is reported.

Discovery of SB-100 was made at Cyanamid's Stamford, Conn, Research Laboratories. It is produced at Cyanamid's Bridgeville, Pa, plant and sold by Cyanamid's Specialty Products Department with offices at Charlotte, NC and Bound Brook, NJ.

Disperscon Vat Powders

American Aniline Products, Inc, New York, has announced the release of a new line of Disperscon Vat Powders in a highly concentrated form. The powders, which are said to possess qualities such as excellent dispersion, rapid-wetting, and nondusting, are available in the following colors: Blue BCL, Red Brown, Orange RRT, Navy Blue BN, Olive Green B, Flavone GC, Dark Blue BO, Olive R and Pink FF.

All the desirable properties of vat dye pastes have been maintained in the new line in addition to the higher concentration of color, it is claimed.

The new products are said to be eminently suited for all of the application techniques normally employed in vat dyeing and particularly so in the case of package and beam dyeing.

According to AAP, all these characteristics, while welcome to the dyer, will also mean even, bright shades with excellent washability and light fastness for the ultimate consumer.

Vits Dryer

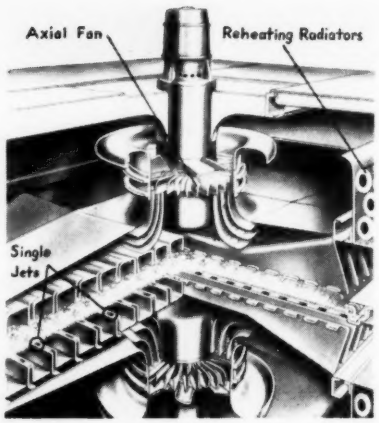
High-speed, high-efficiency drying of all fabrics is claimed with the compact Vits "Lay-on-air" dryer. Manufactured by Vits-Electro Machine Works, Germany, it is now being introduced in the United States by Cosa Corporation, 405 Lexington Ave, New York 17, NY. This dryer is also reported to be excellent for use with curing, polymerizing, shrinking, pigment dyeing and other finishing processes.

This dryer utilizes the "lay-on-air," single pass, forced convection drying system. Fed and held by one pair of rollers at each end of the dryer, the fabric floats free and tensionless between two single-jet blower systems above and below. The rollers control speed and desired stretch or shrinkage of the fabric. No mechanical suspension is used—there is no contact with internal hot surfaces. Fabrics are free to shrink in filling and, if desired, warp also. Ordinary dress-weight fabrics can be run at speeds above a hundred yards a minute, and speeds considerably higher are also possible, it is claimed.

A drying medium mixture of steam and air at 300 to 400° F is blown at high speeds by the axial fans through conduits into the single jets which vent it perpendicularly against the fabric. The resulting evaporation rate is said to be greater than with conventional drying methods and insulating dead air zones on the fabric are destroyed. The steam then passes through reheating radiators and back to the fans at a reported 88% efficiency. Such a steam-air mixture is said to provide excellent protection against otherwise damaging high temperatures and results in an extremely soft "touch," especially with wool fabrics. The drying "focus" is claimed to be so well balanced that the most sensitive fabrics and fibers are dried without distortion or mutilation. Specific power consumption is said to be extremely low.

The Vits "Lay-on-air" system reportedly provides a drying efficiency of up to 90 lbs water evaporation per sq yd of dryer per hr. It is stated that specific steam consumption is 1.4 lbs per lb of water evaporated. It is further stated that a two-compartment dryer (30 to 45 feet long depending on width of fabric) can evaporate up to 1300 lbs water per hr at a steam pressure of 90 lbs/sq in. Higher productive capacity is obtained by adding more compartments.

The evaporative efficiency of the Vits dryer is said to permit a great saving in floor space and, combined with excellent insulation against thermal loss, to result in a low steam consumption. Higher temperatures are also possible permitting drying, curing and polymerizing in one pass.



Cutaway drawing of Vits Dryer

CSI Announces SMT Tensiometer; New Sensing Head

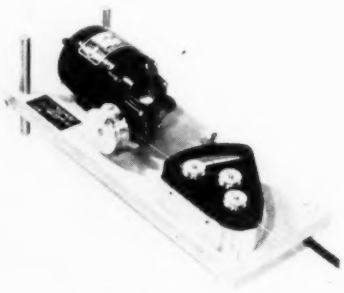
Custom Scientific Instruments, Inc, Kearny, N J, has announced the SMT Tensiometer developed by Coats & Clark Research Department, Newark, N J. This unit was designed to measure thread tensions on sewing machines. The thread is drawn through the three pulleys of the tensiometer by means of an electrical motor. The take-off point of the thread from the sewing machine is after the thread guide above the needle.

Tension measurements are desired when breakage occurs in sewing. This unit reportedly affords simple and easy means of measuring the tension. Other possible uses for the tensiometer are the effect of finishes, twist, softeners, lubricants on thread and of natural and synthetic threads on a sewing machine under constant conditions through tension measurements. The SMT Tensiometer is available in different ranges up to 2000 grams.

Custom Scientific has announced also the addition of an increased range sensing head for the High-Speed Recording Tensiometer. This unit was developed by the Summit Research Laboratories of the Celanese Corporation for measuring the amount of tension applied in various textile processing operations.

The sensing heads are sold separate or with the electrical equipment and cart. All are designed for ease of installation in the running yarn. It is necessary only to place the two pulleys over the running yarn and twist the sensing head until the yarn forms an S shape over the pulleys. The new head reportedly has a maximum range of 50 pounds and a maximum sensitivity of 1 mm deflection per 30 grams tension.

The tensiometer sensing head is said to have a frequency response such that tension variation occurring at speeds up to 120 CPS will be translated into electrical signals with negligible loss or attenuation. These signals can then be amplified and recorded directly on standard direct wiring systems which are made and sold commercially by recording manufacturers.



SMT Tensiometer

Electrocolorset

The first large commercial-size Electrocolorset machine for automatically scouring, setting, dyeing and finishing ladies' nylon hosiery is being delivered and will be in operation this summer, it is learned.

This machine, which is manufactured by Proctor & Schwartz, Philadelphia, will be used primarily for finishing seamless nylon hosiery. The unit reportedly produces 150 dozen pairs per hour and will require 6 boarders, 2 strippers and 1 operator-colorist per shift.

A second Electrocolorset is scheduled for shipment later this year. It will be used primarily for ladies' nylon full fashioned hosiery.

The machine is offered on a purchase or rental basis, plus a nominal royalty based on production per year for use of the Electrocolorset Process.

Redi-Set-P

Northern Dyeing Corp, Washington, N J, is reported to have perfected a new finish for peau de soie that makes this fabric washable. The finish is known as "Redi-Set-P."

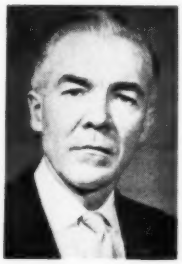
Company officials believe that the new finish will greatly increase peau de soie yardages in the forthcoming months and expand its application into hitherto untapped resources in the garment industry.

Peau de soie treated with Northern Dyeing's Redi-Set-P finish reportedly has a maximum 3% residual shrinkage and is completely washable in temperatures of 150° F.

• NAMES IN THE NEWS •

Stam

Schulze



Conlon

Rottschaefer

Schlaeppi

Bouroff

Paul B Stam has joined Burlington Industries to head a program of research that will concern itself primarily with cotton fiber. His title is that of area research director.

Dr Stam comes to Burlington from Dan River Mills, where for the past five years he has been assistant director of research. He will make his headquarters in Greensboro.

Dr Stam is a member of AATCC's Executive Committee for Research and is secretary of the Research Committee for the Piedmont Section.

Chris C Schulze has been appointed manager of manufacturing of the Dyestuff and Chemical Division of General Aniline & Film Corp, succeeding **Joseph W Lang,** who for a number of months has been inactive because of ill health. Dr Schulze will direct the operations of the divisional plants at Rensselaer, NY, Linden, NJ, Calvert City, Ky, Huntsville, Ala, and the Purchasing Dept for the Dyestuff and Chemical Div. He will make his headquarters at the Dyestuff and Chemical Division offices, 435 Hudson St, New York.

Succeeding Dr Schulze as manager of the Rensselaer plant is **Joseph W Conlon,** who has held various executive positions there in all phases of research and manufacturing.

Bernard W Rottschaefer will serve as production manager at Rensselaer.

William F Burchfield has been appointed supervisor and **Kenneth M Spicer** assistant supervisor of Technical Service in the International Nickel Company's Development and Research Division.

Mr Burchfield has been serving since 1947 as assistant director of technical service under **W A Mudge,** whose appointment as the company's special representative on educational programs was announced recently.

T Vickerstaff has been appointed chief colorist of the Dyestuffs Division of Imperial Chemical Industries Ltd, succeeding **G O Mitchell,** who retired May 31st after 3 years' service with the Company.

Dr Vickerstaff, author of the noted textbook "The Physical Chemistry of Dyeing", joined ICI in 1955. He was appointed assistant chief colorist of the Dyestuffs Division in 1949.

Robinette Research Laboratories, Inc, Ardmore, Pa, has announced the addition of **Joseph Bussian, George Kehl** and **Alex Marinelli** to its staff of technologists.

Messrs Bussian and Kehl were most recently with Atlas Powder Co.

American Cyanamid Co has named **Donald L Griswold,** assistant sales manager of its Dyes Department at Bound Brook, NJ, to the new post of general manager of the Marketing Department of the Jefferson Chemical Co, Houston, Texas. Jefferson Chemical, an important producer of petrochemicals, is jointly owned by Cyanamid and The Texas Co.

The Company has announced also the appointment of **Richard J Turner** as resident technical director of its Fortier Plant at New Orleans, La. Prior to this new appointment, Dr Turner was director of process development for the Fine Chemicals Division at Cyanamid's Bound Brook laboratories.

Griswold

Turner

Fernand Schlaeppi has been named head technician at Ciba Co, Inc's New England Branch.

Mr Schlaeppi was appointed to the staff of Ciba Co Ltd, Montreal, Canada, in 1951, and in this capacity he was responsible for technical demonstration and the evaluation and introduction of new products and procedures.

E F Drew & Co, Inc, has announced the appointment of **Peter P Bouroff** as Chemical Division Manager. Dr Bouroff will be in charge of production for the laundry, detergent, textile, leather, power chemical, automotive, oil and chemical, and dairy divisions of the company.

For the past six years he was plant manager of the American Alcolac Corp, Baltimore, Md, where he built and operated the plant.

Walter H Hindle, associate director in charge of dyeing and finishing for The Chemstrand Corporation, has been promoted to the newly created position as associate director in charge of the textile research divisions.

Mr Hindle's new responsibilities will include the over-all direction of the dyeing and finishing and textile processing divisions.

Prior to joining Chemstrand, Mr Hindle was in charge of the dyeing and finishing research and development department of Burlington Mills Corporation at Greensboro, NC.

J William Zabor has been named director of research for Wyandotte Chemicals Corporation.

Dr Zabor joins Wyandotte from the Pittsburgh Coke and Chemical Company where he served most recently as assistant to the vice-president, Chemicals Division.

Hopper

Perry

Two members of the staff of the Southern Regional Research Laboratory in New Orleans, La, were honored in Washington, D C, recently when they received Superior Service Awards from the U S Department of Agriculture for their contributions to research on the utilization of Southern farm crops.

They were **Mrs E L Skau,** librarian, and **T H Hopper,** head of the Analytical, Physical-Chemical and Physics Section.

Stein, Hall & Co, Inc, has announced the appointment of **Frank W Perry** as manager of its Domestic Starch Department. Mr Perry will be located in the firm's New York Office and will work in close cooperation with the Company's various industry departments and branch offices in promoting the sale of starches and dextrins.

Mr Perry was manager of the Company's Charlotte, NC, Branch for the past eight years.

H W McNulty, formerly technical assistant to the director of product development, Solvay Process Div, Allied Chemical & Dye Corp, has been named technical assistant to the manager of the Organic Chemicals Section.

T W Reed, a salesman at the Company's Boston Branch, succeeds Mr McNulty as technical assistant to the director of product development.

The promotions of **C L Martin** to superintendent of services, **Robert L Axtell** to superintendent of production, **L W Jarrett** to supervisor of personnel and safety, and **Harvey A Hammond** to general foreman at the Moundsville, W Va, Plant, have been announced by National Aniline Division of Allied Chemical & Dye Corp.

Messrs Martin, Axtell and Jarrett have been at the Moundsville plant respectively as assistant plant superintendent, chief production engineer, and general foreman. Mr Hammond has transferred from the Buffalo plant, where he has been shift foreman.

ABSTRACT

The Techniques in Printing Nylon Fabrics

Fletcher, R E, *Textile Mfr* **81**, 652-4, December, 1955.

The main difficulties encountered in printing nylon, e g, the long steaming times and the difficulty of obtaining deep shades, are attributable primarily to the closely knit molecular structure of nylon, which imparts the high tenacity and hinders the entry of water and dyes.

The author states that gum tragacanth and methylcellulose give poor outlines, and bleeding occurs during steaming. Wheat starch gives poor penetration. British gum is better, but is inferior to gum Senegal and Nafka Crystal gum, the latter being considered the most suitable thickener.

Azoic salts and related products are not recommended, since the shades are hard to develop satisfactorily and lack fastness. Basic dyes have good affinity but are fugitive. The leuco vat esters have little affinity for nylon. Chrome dyes are not satisfactory, the entry of chrome into the fiber being difficult.

In general the same range of dyes used for printing acetate is also suitable for printing nylon, but the shades produced are duller and often quite different. The lightfastness is also generally poorer than on acetate. Steaming of nylon printed with disperse dyes normally takes one hour in the cottage steamer, but if certain additions (eg, diethylene glycol and glycerine) are made to the paste, fixation can be obtained in a 10-minute aging.

Many acid and direct dyes possess good affinity for nylon. The author states that the application of these dyes is facilitated by the addition of certain assistants (eg, hydroxy acetic acid, ammonium oxalate, urea, and Cellosolve). It is necessary to select the dyes and assistants very carefully.

Experiments are described in which a large number of direct and acid dyes were printed on nylon, with various assistants and under various steaming conditions.

Vat dyes can be printed on nylon, using a similar type of thickening as on cotton, but the hygroscopic agents should be kept to a minimum to avoid flushing. An aging of 10-20 minutes is usually sufficient. Prints show good washfastness, but the lightfastness is inferior to that on cotton. It can, however, be improved by steaming after aging (eg, for ¾ hour at 25 psi).

The Neolan-type dyes can be printed on nylon, using a paste acidified by lactic acid. They are said to have good fastness to light and washing. The Cibalan-type dyes also give good prints; a special printing formula using ammonium tartrate is recommended.

The author also explains the application of the Orema dyes (pigments).

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